AD-A036 554 PACIFIC NORTHWEST RIVER BASINS COMMISSION VANCOUVER WASH F/G 8/6
COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
FEB 71 K E JOHNSON, A M GRANO, W A POST

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1 OF 5

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RIGATION



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1 COLUMBIA

This appendix is one of a series making up the complete Columbia-North Pacific Region Framework Study on water and related lands. The results of the study are contained in the several documents as shown below:

Main Report

Brochure Report

Appendices

| | | | |
|---|---|---|---|
| I. | History of Study | IX. | Irrigation |
| II. | The Region | X. | Navigation |
| III. | Legal & Administrative Background | XI. | Municipal & Industrial Water Supply |
| IV. | Land & Mineral Resources | XII. | Water Quality & Pollution Control |
| V. | Water Resources | XIII. | Recreation |
| VI. | Economic Base & Projections | XIV. | Fish & Wildlife |
| VII. | Flood Control | XV. | Electric Power |
| VIII. | Land Measures & Watershed Protection | XVI. | Comprehensive Framework Plans |

Pacific Northwest River Basins Commission
1 Columbia River
Vancouver, Washington

# Irrigation



APPENDIX IX

(6) Columbia-North Pacific Region Comprehensive Framework Study of Water and Related Lands. Appendix IX. Irrigation,



(10) K. E./Johnson, A. M./Grano, W. A./Post, D. R./Wagoner R. J./Coffman

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APPENDIX IX
Irrigation

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| Upper Columbia Development Office, Spokane, Washington | Subregions 1, 2, 3, 8, 11 |
| Snake River Development Office, Boise, Idaho | Subregions 4, 5, 6 |

This appendix to the Columbia-North Pacific Region Framework Report was prepared at field level under the auspices of the Pacific Northwest River Basins Commission. It is subject to review by the interested Federal agencies at the departmental level, by the Governors of the affected States, and by the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.

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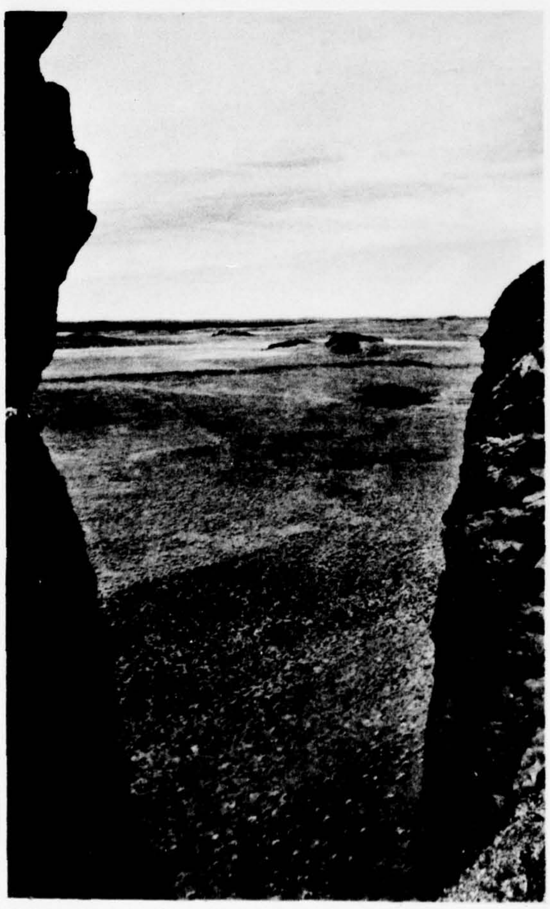


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# REGIONAL SUMMARY

## FOREWORD

Appendix IX, Irrigation, is one of a series of volumes presenting data and information for the Columbia-North Pacific Framework Study. It is the culmination of efforts of many state and Federal agencies. The purpose is threefold: (1) to identify all irrigated and potentially irrigable lands: (2) to determine the water required to irrigate these lands; and (3) to project how production from irrigated land can meet food and fiber needs for the region. Points of time specifically examined include the present (1964 and 1966 base years), 1980, 2000, and 2020.

* of Appendix IX, Irrigation,

1/ As shown in Appendix II, The Region, the Columbia-North Pacific Region has been divided into 12 subregions. The Irrigation Appendix presents data under the general headings of: (1) The Setting, (2) The Role of Irrigation, (3) The Need for Irrigation, and (4) The Potential to Meet the Needs for each of the subregions and, largely in the form of a summary, for the region as a whole. In the above four general headings, the following information is given.

(1) The Setting--Under this heading is a brief and concise description of the physical and cultural factors which set the stage for descriptions of the function of irrigation. Most of this material can be found in much greater detail in Appendix II. It is represented here in a much briefer form as a convenience to help the reader gain an understanding of the particular area he is reading about. A resume of the history and growth of irrigation concludes this section.

(2) Present Status--The characteristics of the irrigated areas, production of irrigated crops, the value of that production, and the economic and social impacts are described in this section. Also included is information on the use, application, and quality of water and on the adequacy of the total supply.

(3) Future Needs--Projections of acreage requirements for irrigation in 1980, 2000, and 2020 to meet food and fiber needs are presented in this section. Projected production and yield are also estimated. Water needs for the inadequately irrigated lands and for the new lands required to meet irrigation needs are also included.

(4) The Potential to Meet the Needs--All the potentially irrigable lands are identified by classes under this heading. The total presently unused water supply for the study area is also discussed. Where possible, private, state, and Federal potential developments are also briefly described. In The Region portion of the Appendix is a section on the productivity of irrigation based on climatic factors.






*Water and land are among the most valued resources of the Region. Melting of the vast snowpacks provides runoff which is stored and diverted to the lands to produce a wide variety of crops. (Bureau of Reclamation)*

# T H E   R E G I O N

## THE SETTING

The Columbia-North Pacific Region, an area of 274,400 square miles or nearly 176 million acres, lies in the northwest corner of the contiguous United States. All of the state of Washington, most of Oregon and Idaho, that portion of Montana west of the Continental Divide, and small areas of Utah, Wyoming, and Nevada make up the region. Its boundaries are the Pacific Ocean on the west; the Canadian border on the north; the Continental Divide on the east; and the southern rim of the Snake River drainage and the southern Oregon state line, excluding the Oregon portion of the Goose Lake, Klamath, and Smith River drainages, on the south.

Three major drainage systems are located within the region. The Columbia River system, by far the largest, drains nearly three-fourths of the region. The second largest drainage system is comprised of those streams in Oregon and Washington flowing directly into either the Pacific Ocean, Puget Sound, the Straits of Juan de Fuca, or Straits of Georgia. The Oregon portion of the interior-drained Great Basin represents the third system.

Major mountain ranges and large valleys and plateaus dominate the topography. This physical framework with its attendant land and water resources has influenced the patterns of population distribution, human use, and industrial development.

Climate is perhaps the most important environmental factor in the Columbia-North Pacific Region affecting irrigation and its potential. The Cascade Range divides the region into two distinct climatic zones--a relatively humid western side and a relatively arid eastern side. The influence of the Pacific Ocean is evident on both sides, however. Marine air masses keep temperatures moderate throughout the region most of the time. Across the plateaus and valleys these moderate temperatures produce longer frost-free periods. The distinctive characteristics of the marine-type climate are greatly modified by distance from the coast, differences in elevation and topographic barriers. Any modification of the air masses tends to increase aridity and produce a more continental-type climatic regime.

Annual precipitation averages about 28 inches over the region. About 27 percent of the Regional area receives less than 12 inches, less than 1 percent receives more than 120 inches, and each state has some areas receiving less than 10 inches. The effect of the

mountains is most noticeable; areas west of the Cascades receive substantially more precipitation than areas to the east. Precipitation generally increases with elevation. Areas on the windward slopes of the mountain ranges receive more precipitation than the plateau and valley areas. Seasonally, summers are dry throughout the region.

Winters bring large amounts of snow in the higher elevations. The spring and summer melting of these snowfields feeds many of the streams in the region. Many of the major streams have desirable qualities including large volumes of water, relatively small amounts of silt, relatively steep gradients, numerous dam and storage sites, maximum runoff during the drier season, and passage through much of the arid portion.

*The effects of mountains in the Region are many; they influence climatic conditions, drainage, and runoff patterns and have been barriers to settlement. (Bureau of Reclamation)*

Natural vegetation can be summarized as extensive areas of forests in the higher elevations and major areas of grasslands and sagebrush in the lower elevations, especially east of the Cascades. Originally, more than 90 million acres of natural grassland covered much of the region; nearly all the untimbered land in the eastern part of Oregon and Washington and southern Idaho was once a vast

expanse of bunchgrass prairie. These grasslands merged rather abruptly into the forests at higher elevations, but throughout the timbered areas at lower elevations they retained their identity.

The abundant natural resources of the Pacific Northwest have been influential in the patterns of settlement and development. Exploitation of them has provided for substantial growth of the region. Forestry and forest products have been and continue to be the industrial leader since the early settlements. Mining of the abundant minerals is also an important industrial activity. Agriculture, which assumed an important role in the 1840's, continues to have great economic importance. It started on a fairly large scale in the Willamette Valley and spread to the rest of the region. Initial efforts were devoted primarily to the production of grain and cattle. Wheat farming became important in the Palouse country and on the Columbia Plateau in areas that were accessible to the existing transportation routes. Much of the arid interior with its vast expanses of grasslands was used to raise livestock.

The Pacific Northwest was for many years dependent upon the waterways for the movement of goods. Its early trade was for the most part with California and the Orient. Physical barriers, including the mountain ranges, vast deserts, and great distances, isolated this area from the settlements of the eastern United States.

An initial effort at land transportation in the Pacific Northwest was the "wagoning" of goods between the settlements having access to the waterways and the newly established inland settlements. The rugged topography, great distances, and poor roads made this form of transportation both slow and expensive and consequently increased the demand for better overland facilities.

The coming of the railroads had a definite impact on the agricultural development. Completion of the transcontinental railroads made possible the opening up and settlement of the arid interior. For example, areas having the physical characteristics to produce grain but lacking adequate transportation networks now could feasibly be farmed. Wheat became the leading export crop. Livestock ranching assumed additional importance; dairy cattle were concentrated west of the Cascades and beef cattle and sheep east of the mountains, especially in the Snake River basin and the Oregon Great Basin.

Today, a vast system of railroads and local, State, and Federal highways provides safe, high-speed access to all portions of the Pacific Northwest and dependable connections with the rest of the Nation. Air transportation serves the entire region including many of the smaller communities. Navigation has retained a role of importance through shipping via the open waters and barging via the slack water provided by the dams, reservoirs, and locks.

The 1960 population of the region was 5,426,000. Approximately 63 percent of these people were classified as urban dwellers, 29 percent as rural nonfarm, and 8 percent as rural farm. Although the region did not quite match the Nation in population growth for the 1950-1960 period (18 percent versus 19 percent), two subregions, the Upper Columbia and the Puget Sound, experienced larger increases. Puget Sound, Subregion 11, is an area of highly concentrated urban development; Upper Columbia, Subregion 2, is primarily rural and has substantial farming developments.

Nearly 2 million people were employed in the region in 1960. Manufacturing, consisting mainly of lumber and wood products; retail trade; professional services; and agriculture were the leading employers. Employment in agriculture, although still a leader, declined during the 1950-1960 decade; this decline was due in part to improved farming methods and increased mechanization.

However, none of the resource development could have reached its present level without the region's most important natural resource--water. The development of the forestry and mining industries to their present highly sophisticated level could not have been accomplished without the parallel development of the water resource. Rivers were used to transport and store cut timber; sawmills were constructed on rivers and bays. Water was used to work the large mineral deposits and to generate the power used by the mining industry. One of the greatest impacts on the region was the placing of water on the land to raise crops. Irrigated agriculture supports most of the settlement on the arid lands between the Cascade and the northern Rocky Mountains.

Irrigation is probably older than recorded history. References to it can be found in the writings of the country of Mesopotamia, more than 2,000 years before Christ. Its development in the Pacific Northwest dates back to the middle 1800's. From a simple beginning it has grown to be of great importance to the overall development of the Pacific Northwest.

Agriculture was not one of the initial attractions which drew people to the Pacific Northwest. Explorers, trappers, traders, and missionaries came to the Oregon country. The first resource to be exploited was fur; forts built as centers for this industry were located west of the Cascades where crops could be planted and livestock raised on the fertile valley soils.

The biggest boon to agricultural development was the discovery of gold in California and later in various parts of the region. The gold rushes of the 1850's and 1860's helped to populate much of the more arid portions of the region. With the miners came farmers and cattlemen. Disappointed miners became homesteaders and contributed to agricultural development. Dryland grain production became the most common form of farming.

However, because great expanses of land located in the arid area east of the Cascades could not support dryfarming, farmers turned to irrigation. Almost from the beginning of settlement in these areas, individual farmers have diverted water from streams. Private companies were soon organized to supply groups of farmers; many simple systems were built to serve one or a few farms. Before the turn of the century the areas of concentrated irrigation development included the Hood River, Yakima, Wenatchee, and upper Snake River valleys.

Many acts of Congress were made to encourage the private individual to settle and develop in the West. These acts all had an important bearing on the history of irrigation development in the Pacific Northwest. The Donation Land Law, 1850-1855, provided for a man and his wife to acquire from 320 to 640 acres of land by simply settling on them. The Homestead Act of 1862 gave a settler 160 acres if he cultivated them and made some improvements. Federal land grants were made to the railroads along the rights-of-way to encourage construction of transcontinental routes. These large tracts were often sold by the railroads to prospective settlers.

Of major importance to irrigation development was the step taken by the Federal Government in 1866 to ensure that it (the Federal Government) would not become the sole owner, operator, and developer of public lands for agriculture. This left the development of irrigation "to local customs, laws, and decisions of courts." It surrendered any control the Federal Government might have over use of water for irrigation from nonnavigable streams and provided that all irrigation must be carried on under state laws.

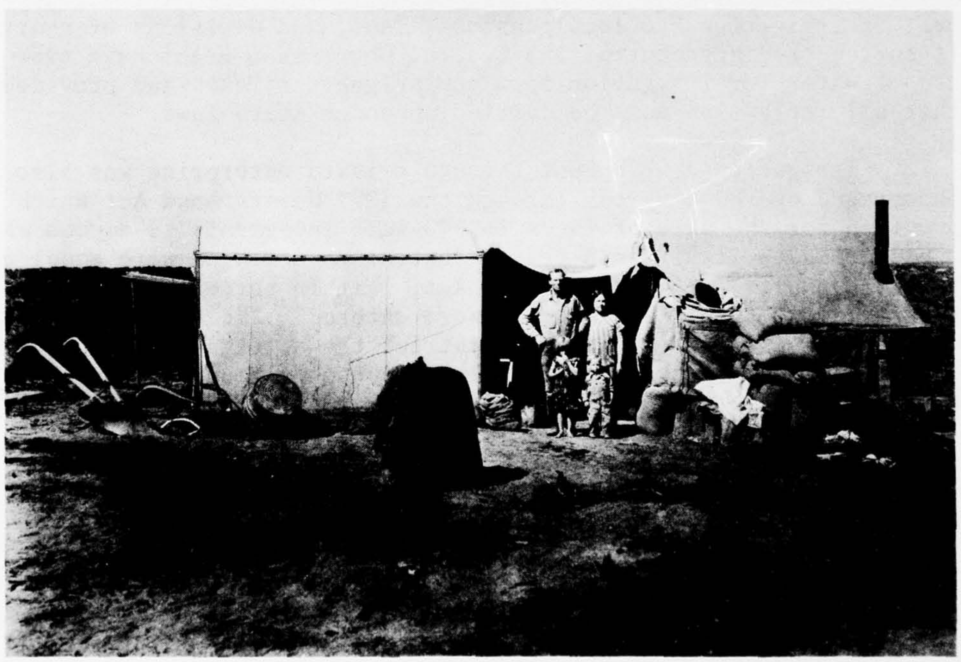
Irrigation development through private enterprise was also encouraged by the Congress through the 1877 Desert Land Act which provided for the sale of lands in 640-acre increments to anyone who would irrigate it within 3 years. Extensive acreages were acquired from the public domain under this Act. Within three months of passage, more than 250,000 acres were entered. The Act was modified by Congress in 1890, in part to restrict the acreage in an entry to 320 acres and to increase the dollar amounts of required improvements. The Desert Land Act is still operating at present.

The Carey Act of 1894 was still another venture to promote irrigation development. This Act was designed to encourage states to take the leadership in irrigation development. It granted each western state 1 million acres of desert land and stipulated that the grants to individuals be limited to 160 acres. However, application of the Act was not entirely successful for several reasons, including improper engineering surveys and the fact that financial and economic risks were all borne by the settlers without Federal and State Government support.

The passage of the Reclamation Act in 1902 enabled the Federal Government to assist in irrigation. While private enterprise had developed a substantial acreage of land for irrigation in the Pacific Northwest, it was apparent that further development would require strong and active support by the Federal Government. Briefly, this Act permitted the Secretary of the Interior to locate and construct irrigation works. Settlers on a Federal reclamation project were allowed to own up to 160 acres (320 for a man and wife) for the purpose of irrigating crops.

Many other acts were passed during the late 1800's and the first 60 years of the 1900's which provided either impetus, procedures, or guidelines for the development of irrigation. This development has progressed from the initial concept of simple stream diversions to the present more complex and dependable systems using, among other things, storage reservoirs, sprinklers, ground water pumping and pressure distribution systems.

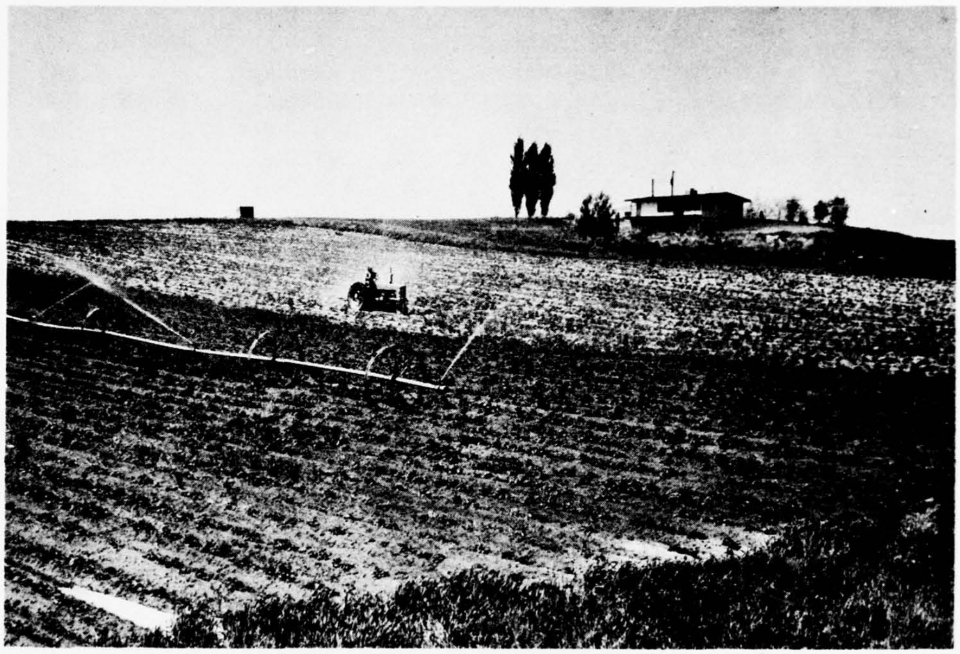
More than 70 percent of the irrigation development in the region was initiated by individuals, cooperatives, and agencies other than the Federal Government. However, a major portion of the irrigated area in the region has received some Federal support, primarily through the providing of supplemental water to many of the irrigated lands and the development of many dry lands.



*Early efforts at irrigation usually involved simple stream diversions and lots of hard work. (Bureau of Reclamation)*

## PRESENT STATUS

A total of 7,344,000 acres is presently irrigated in the region. This represents only about 4 percent of the total land area and 18 percent of the total irrigable (irrigated plus potentially irrigable) acreage. Included in this acreage are irrigated lands in urban use, forest nurseries and seed orchards, recreation sites, and other nonagricultural uses. Table 1 presents the irrigated acreage by source of supply and by state and subregion. The general location of these lands is shown on figure 1.



*In contrast with the early efforts, present irrigation is a highly complex and more dependable undertaking. (Bureau of Reclamation)*

### Characteristics of the Irrigated Area

All portions of the region have some irrigated land. Most of these lands are located east of the Cascades. Significant concentrations occur where large project-type developments have taken place. Individual developments have been limited to lands located near reliable water sources. The plain of the Snake River from west of the Idaho-Oregon state line to the Idaho-Wyoming state line contains more than three million irrigated acres. Most of these lands have been developed through group efforts.

Table 1 - Irrigated Area, 1966 1/
Columbia-North Pacific Region

| Subregion | Irrigated Area (acres) | Source of Supply Surface (acres) | Ground Water (acres) |
|---|---|---|---|
| 1 | 480,000 | 437,000 | 43,000 |
| 2 | 729,000 | 671,000 | 58,000 |
| 3 | 505,000 | 487,000 | 18,000 |
| 4 | 2,485,000 | 1,811,000 | 674,000 |
| 5 | 1,465,000 | 1,397,000 | 68,000 |
| 6 | 276,000 | 265,000 | 11,000 |
| 7 | 542,000 | 496,000 | 46,000 |
| 8 | 18,000 | 14,000 | 4,000 |
| 9 1/ | 244,000 | 143,000 | 101,000 |
| 10 | 181,000 | 174,000 | 7,000 |
| 11 1/ | 92,000 | 57,000 | 35,000 |
| 12 | 327,000 | 312,000 | 15,000 |
| Total (Rounded) | 7,344,000 2/ | 6,264,000 | 1,080,000 |
| Idaho | 3,374,000 | 2,626,000 | 748,000 |
| Montana | 431,000 | 416,000 | 15,000 |
| Nevada | 160,000 | 160,000 | - |
| Oregon | 1,739,000 | 1,578,000 | 161,000 |
| Utah | 7,000 | 7,000 | - |
| Washington | 1,495,000 | 1,339,000 | 156,000 |
| Wyoming | 138,000 | 138,000 | - |

1/ 1965 data for all of Subregion 9 and most of Subregion 11.
2/ Includes 8,760 acres devoted to forest nurseries and seed orchards, recreation sites, and tracts primarily used for wildlife and other related purposes as well as 6,200 acres irrigated range.

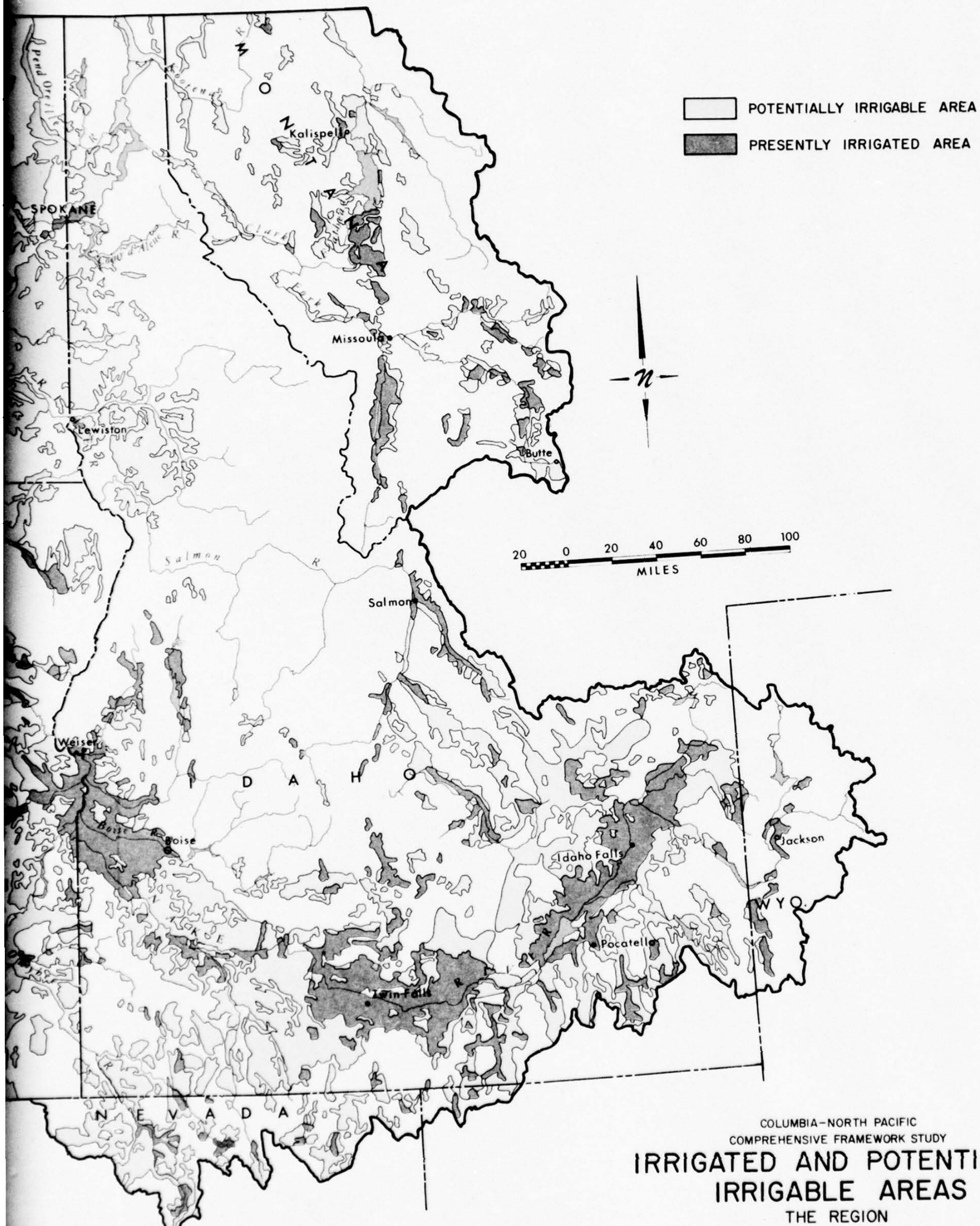
In Washington a large area in the Yakima River Valley and a large area east of the Columbia River from Moses Lake on the north to the mouth of the Snake River on the south collectively contain more than one million irrigated acres. Most of these lands have been developed as large Federal projects.

Although Oregon has more irrigated lands than Washington, it lacks the large concentrations. A substantial amount is located in the Bend-Prineville-Madras area of the Deschutes and Crooked River basins.

Sizable blocks of irrigated land are located in the valleys of the Clark Fork, Flathead, and Bitterroot Rivers in western Montana; these lands for the most part have been developed privately.

Bellingham
Everett
SEATTLE
TACOMA
Olympia
Hoquiam
Aberdeen
WASHINGTON
Wenatchee
Grand
Coulee
SPOKANE
Moses Lake
Yakima
Lewiston
Longview
Kelso
Astoria
Walla Walla
Vancouver
Pendleton
Tillamook
PORTLAND
The Dalles
La Grande
Salem
Newport
Baker
Weiser
Eugene
OREGON
Bend
IDA
Boise
Burns
Coos Bay
Roseburg
Grants Pass
Medford
Lake Abert
NEVADA
PACIFIC OCEAN
Salmon

2



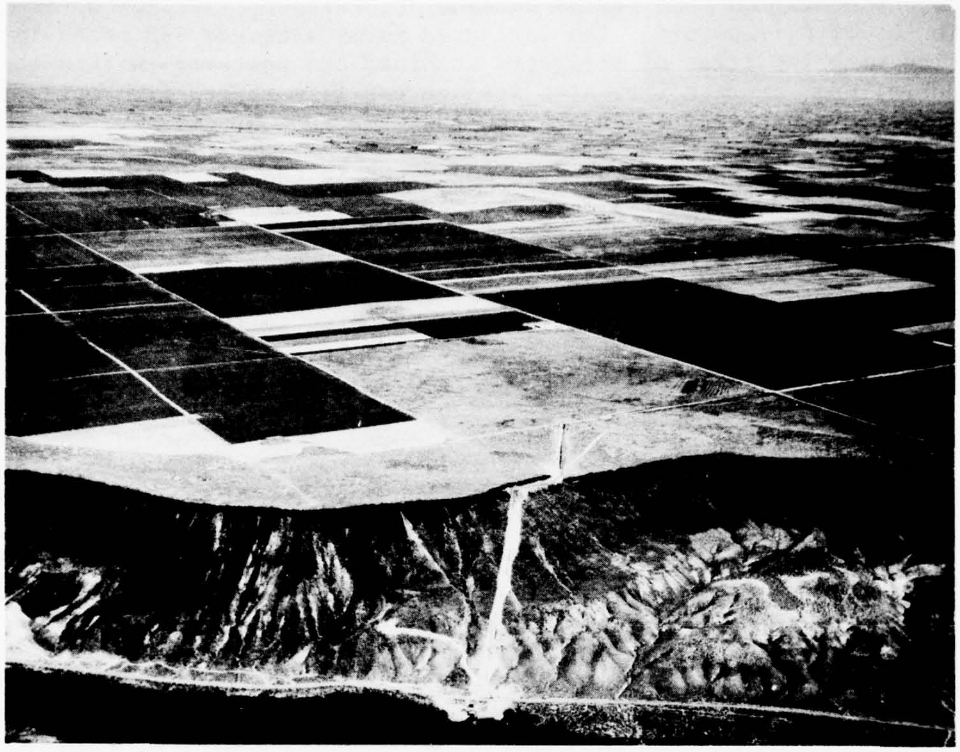

COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# IRRIGATED AND POTENTIALLY IRRIGABLE AREAS

THE REGION

1968

FIGURE 1



*In certain areas of the Region, large corporate irrigation ventures have been undertaken. Here water is pumped from the Snake River to serve a large acreage. (Bureau of Reclamation)*

Most of the remaining irrigated lands in the region east of the Cascades are strung out along stream valleys. Much of these lands have been developed privately through individual and group efforts.

In the Medford area of southwestern Oregon irrigation has developed primarily through group efforts. Along the coast and in the interior valleys of western Oregon and Washington nearly all the development has taken place through the efforts of individuals. Along the coast, irrigation is a marginal venture except for horticultural and vegetable crops, although a considerable portion of the forage for the dairy industry is irrigated. Most field crops can be grown without irrigation in these areas. However, under irrigation, yields increase and quality is enhanced. Irrigation is necessary to produce most specialty crops.

Irrigated farms are usually characterized by a fairly high degree of diversification and very intensive land use. Although there is no average irrigated farm that is representative of the entire region, some of the general characteristics can be identified.

Of more than 117,000 farms in the region in 1964, over 55,000 contained some irrigated land according to the 1964 U. S. Census of Agriculture. The irrigated farms averaged 580 acres in size with 100 acres of irrigated cropland and pasture. Within the subregions, average irrigated acreage per farm ranged from only 30 acres in Subregions 10 and 11 to 630 acres in Subregion 12.

Because much of the data contained in the Census of Agriculture is based on political subdivisions, it was necessary to develop an economic region based on county lines. Irrigated cropland harvested and irrigated pasture totaled 5,590,000 acres in 1964 inside the economic region. The number of acres and the relative percentage for the various crop categories are presented in figure 2. These categories were established by the Office of Business Economics and the Economic Research Service (OBERS); data was derived from the 1964 Census of Agriculture.

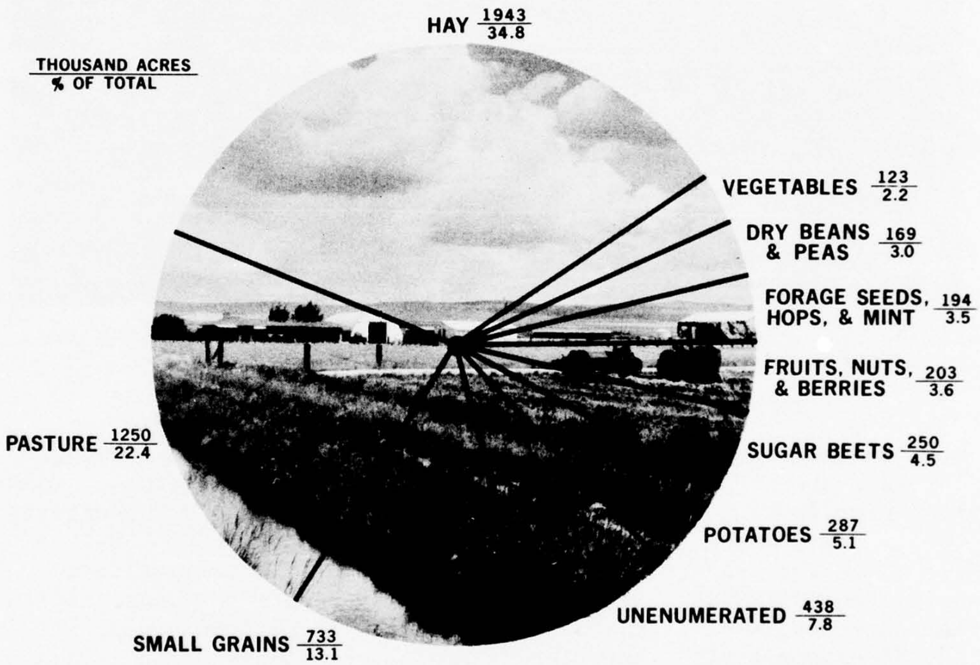



FIGURE 2. Irrigated Land Use and Distribution of Harvested Cropland and Pasture - Columbia-North Pacific Region

Although less than 10 percent of the region's irrigated acreage is devoted to raising potatoes and sugar beets, it is nonetheless one of the Nation's major producers of these crops. Vegetables, fruits, nuts, and berries, which are also of high financial importance to the region, account for less than 6 percent of the acreage.

Hay and pasture utilize 57 percent of the productive irrigated land and complement extensive public and private rangelands in support of the region's livestock industry. Small grains, some of which also support the livestock industry, account for just over 13 percent of the acreage.

The "unenumerated" category includes irrigated crops not included in the preceding categories. These include silage, vegetable seeds, and flax.

## Production of Irrigated Crops

Production from irrigated land accounts for a substantial portion of the total crop production in the region. This is indicated by a summary of 1964 crop production presented in table 2. Most of the region's production for five of the eight crop categories is grown on irrigated land.

Table 2 - Summary of Crop Production, 1964 1/
Columbia-North Pacific Region

| Crop Category | Units | Total Production (1,000) | Irrigated 1/ Production (1,000) | Percent Irrigated |
|---|---|---|---|---|
| Small grains | Tons | 6,096 | 1,108 | 18.2 |
| Hay | Tons | 7,747 | 5,345 | 69.0 |
| Dry beans and peas | Cwt. | 6,834 | 2,854 | 41.8 |
| Sugar beets | Tons | 4,588 | 4,584 | 99.7 |
| Potatoes | Cwt. | 55,419 | 54,118 | 97.7 |
| Vegetables | Cwt. | 20,464 | 14,678 | 71.7 |
| Fruits, nuts, and berries | Tons | 1,258 | 1,118 | 88.9 |
| Forage seed, hops and mint 2/ | Lbs. | 407,222 | 95,561 | 23.5 |

1/ Derived from 1964 Census of Agriculture and Agricultural Statistics.
2/ Listed as "miscellaneous" in Appendix VI, Economic Base and Projections.

The percentages for categories containing many crops can be somewhat deceiving. For example, 24 percent of the category containing forage seed, hops, and mint is grown under irrigation. However, a further breakdown would show that virtually all of the hops and mint are grown under irrigation. A breakdown of forage seeds to specific crops would show some grown entirely under irrigation and some entirely on dry land while others are grown under both.

Irrigated crop yields for 1964 were derived from the Census of Agriculture and Agricultural Statistics. Yields of selected

major irrigated crops are presented in each of the subregion writeups.

## Value of Production

The sale value of crops, livestock, and livestock products from irrigated agriculture was estimated to be $740 million in 1964, nearly half of the total $1.5 billion agricultural sales for that year, according to the Census of Agriculture. This evaluation was made at the farm level and does not include value added from processing and marketing. It includes $480 million worth of crops grown under irrigation exclusive of the estimated production used for livestock feed.

The value of livestock and livestock products associated with irrigated land was estimated to be $260 million. This estimate was based on the proportion of total feed requirements that were grown on irrigated land.

## Economic and Social Impacts

Irrigation has played a major role in the economic development of the Columbia-North Pacific Region. Without it there would be little or no agriculture in the arid portions of the Region. Not as obvious but just as real is the importance of irrigation to the more humid areas. Irrigation protects against the damages of drought, increases the quality and yields of the crops, and provides the opportunity for diversification in farming.

The Columbia-North Pacific Region has the necessary elements tc provide, at the least, its share of the Nation's demand for food and fiber. The combination of potentially irrigable lands, abundant water supplies, and favorable climate make the Region ideally suited to irrigation development.

Yields and quality of nonirrigated crops vary greatly from year to year depending upon the effectiveness and timing of natural precipitation. With a dependable irrigation water supply there is the assurance that predictable yields of specified quality can be obtained. A wider range of crops can be grown under irrigation. This ability to diversify cropping patterns permits the agricultural industry to shift its production activities to meet changing market demands. Greater yields of higher quality crops plus flexibility in crop production results in a higher economic level and more stability in the Region's agricultural economy.

In addition to the overall impact of irrigation on the Columbia-North Pacific Region, there is a definite impact on the individual

farms. It provides means to intensify production and enables the farmer to expand the volume of his business and increase both his yields and returns from his investment and labor. It is an important factor in helping individual farmers to meet rising costs of land ownership, labor, and machinery.

Irrigation provides additional job opportunities in the closely associated fields of processing and marketing. Also, a larger volume of business for service industries which provide supplies and equipment to the farmer results from irrigation development. Nearly all facets of the Region's economy are stimulated and benefits to many other portions of the Nation are realized in the manufacture, transportation, and handling of goods and services associated with irrigation.

An indication of the impact of irrigation in the region can be seen in the value of production and the employment stemming from irrigated agriculture.

## Economic Multipliers

Economic studies of irrigated areas have been made that can serve as indicators of the economic activity expected as an impact from irrigation. One such study, which analyzed the impact from the irrigation development in the Columbia Basin Project in eastern Washington, concluded that for each additional dollar of income on irrigated farms there is $2.54 in income generated in the nonfarm sector. A similar study in New Mexico indicated a farm-to-nonfarm income ratio of 1.00 to 1.97. A third study done in an irrigated area in western Colorado showed each $1.00 of farm income generated between $1.97 and $2.32 in associated industries and enterprises. Another study shows that for each dollar in net increase in crop production due to irrigation a nonfarm value of $5.68 in new business was generated throughout Nebraska. These analyses demonstrate the growth-producing effects of irrigated farm production on an economy.

The farm-to-nonfarm income multipliers in these studies range from 1.97 to 5.68. The wide range is dependent in part upon the condition of the local economy existing before irrigation development took place. In other words, if the agricultural economy of the area being studied was already well developed with adequate service, supply, and processing facilities prior to irrigation development, an increase in farm output resulting from irrigation would not have as dramatic an effect as it would in an area where these particular facilities had to be developed. In addition, the impact is influenced by the location of the facilities which process the locally grown agricultural commodities. If the area being studied has the facilities to process the irrigated crop production, the local economic impact will be greater than if the crops have to be shipped elsewhere for processing.

## Employment

Agricultural employment in the Columbia-North Pacific Region has declined since 1940. The total figure for 1960 was 156,000 as estimated from the Office of Business Economics data and the Census of Population. It is continually decreasing. Even so, the total agricultural output has been increasing rapidly because of greater labor efficiencies, specialization, increased mechanization, and improved farming practices.

Irrigation has played a major part in this continually increasing agricultural production. In 1964, of the total 21 million acres of cropland, only 7 million were irrigated. However, employment on irrigated farms was estimated to be 77,000 in 1964, more than 50 percent of the estimated employment on all farms. The estimate for irrigated farms includes farm operators and hired help who worked more than 150 days during the year.

In addition to the on-farm or basic agricultural employment, it has been estimated that about 22,000 workers were employed in the Region processing the output from irrigated land. This does not include workers engaged in transporting and marketing products from irrigated land. It is estimated that more than 100,000 workers in these latter industrial categories were needed to handle the products from irrigated lands.

## Use of Water

In 1966, 33.1 million acre-feet of surface and ground water were diverted to irrigate the 7.3 million irrigated acres. Return flows amounted to 17.7 million acre-feet, resulting in a net depletion of the region's water supply of 15.4 million acre-feet. About 90 percent of the diversions came from surface sources (including storage) and was used on 85 percent of the lands. The remaining 10 percent of the water supply came from ground water and was used on the remainder of the irrigated area. Some 2.0 million acres are subject to shortages averaging about 2.3 million acre-feet annually. Estimated water use for 1966 is shown in table 3 and summarized below:

Irrigation Water Use, 1966 Level

| Source | Irrigated Area (1,000 acres) Adequate Supply | Inadequate Supply | Total | Diversions (1,000 AF) |
|---|---|---|---|---|
| Surface Water | 4,502 | 1,762 | 6,264 | 29,841 |
| Ground Water | 872 | 208 | 1,080 | 3,236 |
| Total | 5,374 | 1,970 | 7,344 | 33,077 |

Table 3 - Irrigation Water Use
Columbia-North Pacific Region

| Subregion | Diversions Surface Water | Ground Water | Total | Return Flow | Depletion |
|---|---|---|---|---|---|
| | (All Figures 1,000 Acre-Feet) | | | | |
| 1 | 1,844 | 130 | 1,974 | 1,244 | 730 |
| 2 | 3,060 | 170 | 3,230 | 540 | 2,690 |
| 3 | 2,400 | 65 | 2,465 | 1,325 | 1,140 |
| 4 | 11,445 | 2,096 | 13,541 | 8,621 | 4,920 |
| 5 | 6,159 | 211 | 6,370 | 3,395 | 2,975 |
| 6 | 1,050 | 35 | 1,085 | 552 | 533 |
| 7 | 2,115 | 168 | 2,283 | 1,171 | 1,112 |
| 8 | 23 | 7 | 30 | 10 | 20 |
| 9 | 330 | 239 | 569 | 197 | 372 |
| 10 | 589 | 11 | 600 | 261 | 339 |
| 11 | 121 | 60 | 181 | 30 | 151 |
| 12 | 705 | 44 | 749 | 327 | 422 |
| Total | 29,841 | 3,236 | 33,077 | 17,673 | 15,404 |
| Idaho | 15,515 | 2,324 | 17,839 | 10,958 | 6,881 |
| Montana | 1,786 | 50 | 1,836 | 1,183 | 653 |
| Nevada | 448 | 0 | 448 | 110 | 338 |
| Oregon | 5,462 | 445 | 5,907 | 2,733 | 3,174 |
| Utah | 17 | 0 | 17 | 5 | 12 |
| Washington | 5,913 | 417 | 6,330 | 2,142 | 4,188 |
| Wyoming | 700 | 0 | 700 | 542 | 158 |

The various paths traveled by waters diverted for irrigation are illustrated in figure 3. Values shown represent totals for the Columbia-North Pacific Region. Most water diverted is measured and therefore provides a reliable base for estimating other values. Water use is based on the acreage irrigated in 1966 and average water supplies available from about 1928 through 1966. Therefore, diversions, farm deliveries, and crop use are less than requirements by the amounts of estimated average annual shortages.

Of the 33.1 million acre-feet diverted for irrigation, an estimated 21 million acre-feet was delivered to the farms and 12.1 million acre-feet was lost from the distribution systems through seepage and operational waste. Irrigated crops used some 10 million acre-feet of the farm deliveries, and the remaining 11 million acre-feet was lost from the irrigated fields as surface runoff and deep percolation.

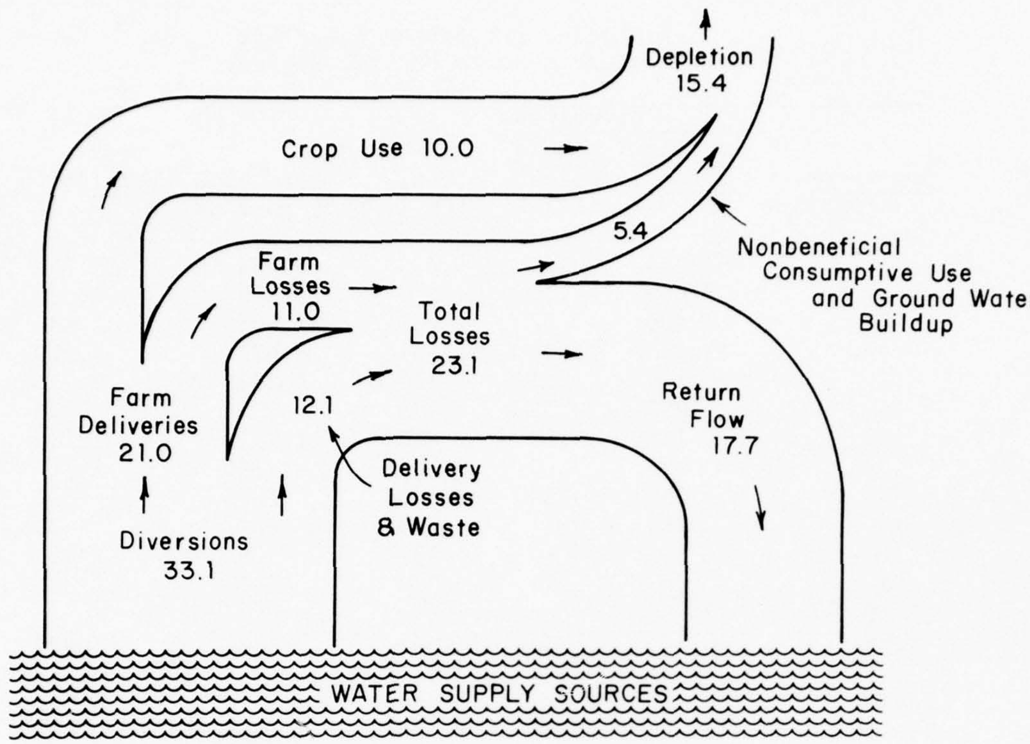



FIGURE 3. Irrigation Water Uses in Columbia-North Pacific Region (million acre-feet)

Total loss and waste amounted to about 23.1 million acre-feet, of which about 20 percent or 4.6 million acre-feet were estimated to be lost through evaporation and transpiration along waterways and in other seeped, noncropped areas. This loss is referred to as nonbeneficial consumptive use because the water does not contribute to irrigated crop production. An additional 800,000 acre-feet of loss has been identified as a depletion because it is contributing to a significant ground water buildup in the Columbia Basin Project area in Subregion 2. The remaining 17.7 million acre-feet of loss returns to surface and ground water sources.

The estimated depletions of 15.4 million acre-feet include the previously discussed crop use, nonbeneficial consumptive use, and the irrigation contribution to ground water buildup. Depletions are also equal to the diversions minus return flows.

*A common method of starting water from its stream channel to the lands is a diversion dam. Here water is impounded behind a small dam and diverted toward the land via a canal. (Bureau of Reclamation)*

## Adequacy of Supply

For purposes of this study, lands are considered to have an adequate supply if the sum of the shortages in any 10-year period does not exceed 1 year's diversion requirement. The most critical period for determining adequacy of irrigation supplies was during the early 1930's when many existing irrigation developments were not in operation. Shortages for lands brought under irrigation after that time were estimated from simulated reservoir and river operations.

About 2 million acres in the region have annual shortages averaging 2.2 million acre-feet annually as shown on table 4.

Most shortages result from overappropriation of low summer flows; however, some 208,000 acres served from ground water experience shortages generally because of overdevelopment and consequent lowering of the ground water table. About three-fourths of these lands are located in the Upper Snake Subregion. Most of the remaining

Table 4 - Inadequately Irrigated Lands by Subregion
Columbia-North Pacific Region

| Subregion | Lands with Shortage (1,000 Acres) | Shortage (1,000 AF) |
|---|---|---|
| 1--Clark Fork-Kootenai-Spokane | 195 | 106 |
| 2--Upper Columbia | 37 | 63 |
| 3--Yakima | 106 | 60 |
| 4--Upper Snake | 510 | 704 |
| 5--Central Snake | 393 | 504 |
| 6--Lower Snake | 127 | 130 |
| 7--Mid-Columbia | 251 | 297 |
| 8--Lower Columbia | - | - |
| 9--Willamette | 26 | 15 |
| 10--Coastal | 47 | 38 |
| 11--Puget Sound | - | - |
| 12--Oregon Closed Basin | 278 | 330 |
| Total | 1,970 | 2,247 |

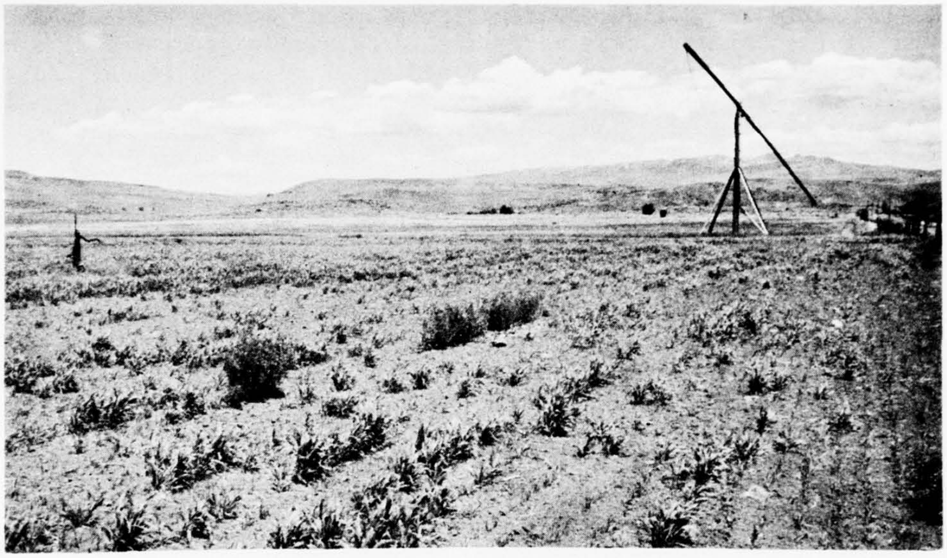
lands having an inadequate ground water supply are located in the Mid-Columbia and Upper Columbia Subregions.

There are 103 reservoirs in the region with capacities greater than 5,000 acre-feet that include irrigation as a function. Their combined active capacities total almost 20 million acre-feet as shown in table 5.

Table 5 - Major Reservoirs with Irrigation as a Function
Columbia-North Pacific Region

| Subregion | Number | Capacity (1,000 AF) |
|---|---|---|
| 1--Clark Fork-Kootenai-Spokane | 14 | 228 |
| 2--Upper Columbia | 9 | 6,425 |
| 3--Yakima | 6 | 1,071 |
| 4--Upper Snake | 16 | 5,311 |
| 5--Central Snake | 25 | 3,507 |
| 6--Lower Snake | 5 | 175 |
| 7--Mid-Columbia | 9 | 687 |
| 8--Lower Columbia | - | - |
| 9--Willamette | 11 | 1,865 |
| 10--Coastal | 6 | 144 |
| 11--Puget Sound | 1 | 106 |
| 12--Oregon Closed Basin | 1 | 21 |
| Total | 103 | 19,540 |

Many of the reservoirs contribute significantly to providing an adequate irrigation water supply. The 41 reservoirs in Subregions 4 and 5 have an active capacity of 8.8 million acre feet and contribute an average of about 4.7 million acre-feet annually to the irrigation water supply. In contrast, the 11 reservoirs in the Willamette Subregion, which were built primarily for flood control, contributed only 2,400 acre-feet to irrigation water supplies in 1966.



*Note the contrast in crop production on the inadequately irrigated land above compared with the lands receiving an adequate water supply below. (Bureau of Reclamation)*

## Application of Water

Gravity methods, including borders, furrows, and wild flooding, are used on about three-fourths of the irrigated lands in the region. Since light-weight sprinkler pipe was introduced in the 1940's, a large part of the new lands brought under irrigation has been sprinkler irrigated.

Early irrigation, confined principally to the arid areas east of the Cascades, was accomplished by simple gravity diversions from tributary streams and wild flooding of adjacent lands. As development expanded, more sophisticated methods of gravity application were adopted. Today border strips and furrow irrigation are most generally used. A changeover from gravity systems to sprinklers is a slow but continuing process. In a few areas where conditions are favorable, principally along upper Snake River tributaries, lands are subirrigated by raising the water table with large gravity diversions.

*The two most common methods of irrigation water application are gravity (left) and sprinkler (right). These large sprinklers are in use on the Columbia Basin Project. (Bureau of Reclamation)*

Along the Columbia River in Oregon and Washington and along the Snake River in southern Idaho where high-lift pumping is required from the river and ground water, wheel-move and self-propelled center-pivot sprinkler systems are commonplace. This is especially true in the sandier areas where potatoes, sugar beets, and alfalfa are extensively grown. The wheel-move and automatic sprinkler systems are also becoming more common each year in the

plateaus of central Oregon and Washington, replacing both older hand-move sprinkler and gravity systems.

Irrigators in western Oregon and Washington are for the most part using hand-move sprinkler systems. Solid-set systems are used for some high-value cash crops, such as cane berries, cranberries, and pole beans. Most of the irrigation occurs on alluvial plains where water is pumped directly from surface sources and wells into farm sprinkler systems. An exception is in the Rogue River valley where gravity is the most widely used means of irrigation.

## Quality of Water

The quality of water for irrigation in the region is generally good to excellent. Surface water is usually of excellent quality for irrigation. The quality of ground water varies significantly, depending primarily on how long it has been in the ground and on the characteristics of the material with which it has been in contact. Aquifers with relatively large recharge and discharge are of better quality than aquifers with low recharge.

During low-flow periods, surface waters are usually of poorer quality than during high-flow periods because they consist mostly of ground water outflow. However, sediment is more of a problem during high-flow periods.

The most significant water quality parameter for irrigation in the region is total dissolved solids; the desired range is below 750 mg/l (milligrams per liter). However, waters with up to 1,200 mg/l of dissolved solids are being used in many areas without harmful effects on soils or crops.

Most streams in the mountainous parts of the region have a dissolved solids content of less than 100 mg/l and some have less than 50 mg/l. Surface waters in irrigated areas generally contain less than 250 mg/l of dissolved solids and rarely exceed 500 mg/l. Streams that have a dissolved solids concentration of more than 1,000 mg/l are the Malheur and Owyhee Rivers in eastern Oregon and Raft River in southern Idaho. The higher concentrations are usually found in the lower reaches of those streams during summer months.

The water quality problems associated with irrigation in the region include toxic substances, salinity, nutrients, temperature, and sediment. They may be significant in local areas and are discussed in the subregional sections.

## FUTURE NEEDS

There is a definite need for a substantial amount of additional irrigation development in the Columbia-North Pacific Region. The determination of this need is based on projected food and fiber requirements for 1980, 2000, and 2020. The amount of new irrigation needed is based on the assumption that all inadequately irrigated land will receive a full water supply. Future water needs for these lands as well as the new lands are discussed in this section. Some of the problems associated with irrigation development are also presented.

Projected food and fiber requirements and crop yields were the inputs used to obtain the needs for irrigated acreage. Production requirements used in this study have their origin in national food and fiber projections. These projections are a joint effort of the Office of Business Economics and the Economic Research Service (OBERS). It is assumed that these projections are National Economic Efficiency projections and are being used for all the Type I river basin studies. The assignment of production requirements to the Columbia-North Pacific Region has been based on trends in the region's historical share of national production.

The projected acreages of irrigated crops, irrigated crop production, and total irrigated area are based on several variables. These variables are as follows: (1) total crop production, (2) total nonirrigated cropland harvested, (3) nonirrigated cropping patterns, (4) nonirrigated crop yields, (5) irrigated crop yields, and (6) the ratio between irrigated land used for agricultural production and the total irrigated area. Since the method used utilizes each of these variables explicitly, any change in the projected and/or assumed values of these variables would result in different projections of the acreages of irrigated crops, irrigated crop production, and total irrigated area. For example, if the projected and/or assumed values for variables (2), (4), (5), and (6) were to be lower than those used, the projected total irrigated area, acreages of irrigated crops, and irrigated crop production would be higher. Conversely, if the future values of the variables were higher, the projections would be lower. Also, if variable (1), total crop production, was projected to be greater (lesser) than what was used, the projections of irrigated area, etc., would increase (decrease). The assumed nonirrigated cropping patterns would also have an effect on the projected acreages and production. Consequently, there are many alternative combinations of the variables which could cause the projected acreages and production values to be the same or different.

The procedures used in developing subregional projections are similar to those used for the region. Major factors considered in their development included the historical production within each

subregion as it relates to the region, production trends, population growth, and the availability of resources for agricultural production. Much more detailed information can be obtained from Appendix VI, Economic Base and Projections.

## Land

Total irrigated area needs for the region are projected to increase from 7.3 million acres irrigated in 1966 to 10.1, 11.4, and 13.5 million acres by the years 1980, 2000, and 2020, respectively. A summary of needs by subregions and states is shown in table 6.

Table 6 - Irrigated Area Needs
Columbia-North Pacific Region

| Subregion | 1966 | 1980 | 2000 | 2020 | Increase 1/ |
|---|---|---|---|---|---|
| | | (1,000 acres) | | | (percent) |
| 1 | 480 | 860 | 950 | 1,320 | 175 |
| 2 | 729 | 1,280 | 1,490 | 1,920 | 163 |
| 3 | 505 | 550 | 570 | 610 | 21 |
| 4 | 2,485 | 2,920 | 3,030 | 3,210 | 29 |
| 5 | 1,465 | 1,950 | 2,120 | 2,460 | 68 |
| 6 | 276 | 440 | 550 | 770 | 179 |
| 7 | 542 | 860 | 950 | 1,220 | 125 |
| 8 | 18 | 60 | 70 | 100 | 456 |
| 9 | 244 | 430 | 850 | 1,000 | 310 |
| 10 | 181 | 280 | 290 | 330 | 83 |
| 11 | 92 | 140 | 190 | 220 | 139 |
| 12 | 327 | 330 | 340 | 340 | 4 |
| Total | 7,344 | 10,100 | 11,400 | 13,500 | 84 |
| Idaho | 3,374 | 4,261 | 4,543 | 5,037 | 49 |
| Montana | 431 | 689 | 730 | 982 | 128 |
| Nevada | 160 | 176 | 181 | 195 | 22 |
| Oregon | 1,739 | 2,277 | 2,770 | 3,139 | 80 |
| Utah | 7 | 7 | 7 | 7 | 0 |
| Washington | 1,495 | 2,542 | 3,018 | 3,973 | 166 |
| Wyoming | 138 | 148 | 151 | 167 | 21 |

1/ Increase from 1966 to 2020.

These projected acreage needs are higher than the levels that would be reached if development progressed at the rate indicated by historical trends. Figure 4 illustrates the gap between an extension of historical trends and irrigation needs. The gap is quite significant in 1980, amounting to 1.4 million acres, and diminishes

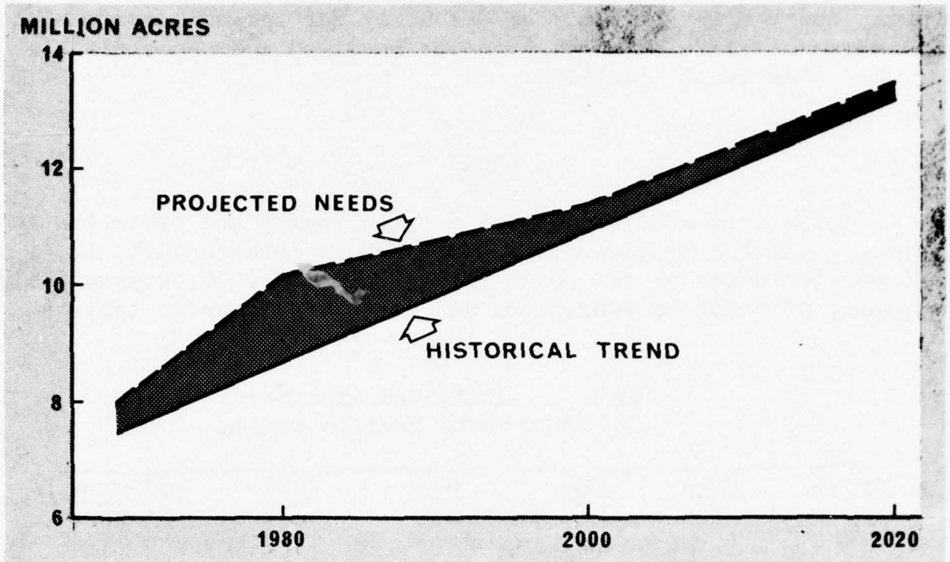



FIGURE 4. Projected Irrigated Acreage Needs Compared to Historical Trend - Columbia-North Pacific Region

to 200,000 acres by 2020. In order for the region to meet projected requirements, irrigation development will have to proceed at a faster rate than it has in the past, especially to meet 1980 needs.

## Food and Fiber Requirements

Projections of national food and fiber requirements were developed by OBERS under sponsorship of the Water Resources Council. These requirements were based on projections of population and per capita consumption and were allocated to the regions. The assignment of production requirements to the Columbia-North Pacific Region was based on trends in the region's historical share of national production. The period 1939 through 1963 with extrapolation to 1980 was used to develop these trends. It is assumed that the trends would hold at the 1980 percentage share through 2020. The requirements were identified for eight crop categories: small grains; all hay; dry beans and peas; sugar beets; potatoes; vegetables; fruits, nuts, and berries; and forage seed, hops and mint.

## Nonirrigated Production Needs

Before the amount of irrigation needed to provide food and fiber requirements could be determined it was necessary to estimate

how much of the requirements would be produced on nonirrigated land. This was done by extrapolating the existing trends in harvested nonirrigated land and then multiplying by the appropriate projected yield. The trend used was harvested nonirrigated cropland in total. Analysis of data from the Agricultural Census indicates that harvested nonirrigated cropland has been decreasing at the rate of 57,000 acres annually since 1949. It has been assumed that the decrease is proportional to all of the nonirrigated crops and would continue at this rate using the 1964 nonirrigated cropland acreage of 7,148,000 as a base. The resulting projected acreages of harvested nonirrigated cropland are shown in table 7.

Table 7 - Projected Harvested Nonirrigated Cropland
Columbia-North Pacific Region

| Crop | Projected Acreage | | |
|---|---|---|---|
| | 1980 | 2000 | 2020 |
| Small grains | 4,124,000 | 3,370,000 | 2,615,000 |
| Hay | 1,214,000 | 993,000 | 772,000 |
| Dry beans and peas | 211,000 | 172,000 | 133,000 |
| Sugar beets 1/ | - | - | - |
| Potatoes 1/ | - | - | - |
| Vegetables | 140,000 | 115,000 | 90,000 |
| Fruits, nuts, and berries | 79,000 | 64,000 | 50,000 |
| Miscellaneous | 295,000 | 242,000 | 188,000 |

1/ Assumed to be all irrigated.

## Irrigated Production Needs

The projected production needs from irrigated land are based on satisfying production requirements remaining after subtracting the nonirrigated production from total requirements. This was first done on a regionwide basis to obtain reference levels. The procedure was then applied to the subregions with subsequent adjustments so that the summation of subregional needs is in conformity with the regional reference levels. Future irrigation needs are directly related to the projected increases in total production and the projected nonirrigated yields, production, and acreage. The irrigated and nonirrigated production needs required to meet the assigned regional food and fiber requirements are shown in table 8.

## Irrigated Crop Yields

Yield projections were initially made by Agricultural Experiment Station personnel for most of the crops grown in the region. These

Table 8 - Estimated Irrigated and Nonirrigated Production Needs to Meet Projected Food and Fiber Requirements by Years 1980, 2000, and 2020, Columbia-North Pacific Region

| Crop Categories | Units | Production Needs 1/ Total 2/ (1,000) | Nonirrigated (1,000) | Irrigated (1,000) |
|---|---|---|---|---|
| 1980 | | | | |
| Small grains | Tons | 9,700 | 5,300 | 4,400 |
| All hay | Tons | 11,800 | 2,700 | 9,100 |
| Dry beans and peas | Cwt. | 8,500 | 4,100 | 4,400 |
| Sugar beets | Tons | 9,000 | 3/ | 9,000 |
| Potatoes | Cwt. | 128,000 | 3/ | 128,000 |
| Vegetables | Cwt. | 33,900 | 7,800 | 26,100 |
| Fruits, nuts, and berries | Tons | 2,100 | 500 | 1,600 |
| Forage seed, hops, and mint | Lbs. | 504,000 | 281,000 | 223,000 |
| 2000 | | | | |
| Small grains | Tons | 10,700 | 5,300 | 5,400 |
| All hay | Tons | 15,300 | 2,500 | 12,800 |
| Dry beans and peas | Cwt. | 10,100 | 4,000 | 6,100 |
| Sugar beets | Tons | 14,000 | 3/ | 14,000 |
| Potatoes | Cwt. | 168,000 | 3/ | 168,000 |
| Vegetables | Cwt. | 44,200 | 7,700 | 36,500 |
| Fruits, nuts, and berries | Tons | 2,800 | 600 | 2,200 |
| Forage seed, hops, and mint | Lbs. | 656,000 | 285,000 | 371,000 |
| 2020 | | | | |
| Small grains | Tons | 11,800 | 4,600 | 7,200 |
| All hay | Tons | 20,900 | 2,100 | 18,800 |
| Dry beans and peas | Cwt. | 12,300 | 3,600 | 8,700 |
| Sugar beets | Tons | 20,300 | 3/ | 20,300 |
| Potatoes | Cwt. | 220,000 | 3/ | 220,000 |
| Vegetables | Cwt. | 57,000 | 7,600 | 49,400 |
| Fruits, nuts, and berries | Tons | 3,700 | 600 | 3,100 |
| Forage seed, hops, and mint | Lbs. | 852,000 | 277,000 | 575,000 |

1/ Comparable Present-Status (1964) information is shown on Table 2.
2/ Rounded from OBERS requirements, Table 3.
3/ No nonirrigated production.

projections were made on statewide bases. From these projections the Economic Research Service developed a set of regionwide yield indexes. These indexes represent the estimated relative changes in irrigated crop yield by 1980, 2000, and 2020 using 1964 as the base year.

Yield projections for each subregion were made by applying the yield indexes to yields developed from 1964 Census of Agriculture and Agricultural Statistics data. This was done on a crop-by-crop basis. Weighted average yields were used for crop categories where production requirements were aggregations of more than one crop. The projected irrigated yields are presented by crop category in the subregional sections of this appendix.

## Irrigated Harvested Cropland and Pasture

The irrigated cropland harvested and irrigated pasture acreage needs are presented in table 9. Irrigated pasture and "unenumerated crops" are included in addition to the eight crop categories established by OBERS for which production requirements were developed.

Table 9 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020, Columbia-North Pacific Region

| Crop Category | Projected Need in Acres | | |
|---|---|---|---|
| | 1980 | 2000 | 2020 |
| | (1,000) | (1,000) | (1,000) |
| Small grains | 1,971 | 1,895 | 2,023 |
| Hay | 2,464 | 2,902 | 3,595 |
| Dry beans and peas | 187 | 212 | 252 |
| Sugar beets | 355 | 505 | 675 |
| Potatoes | 455 | 491 | 556 |
| Vegetables | 166 | 195 | 212 |
| Fruits, nuts, and berries | 206 | 203 | 207 |
| Forage seed, hops, and mint 1/ | 346 | 427 | 510 |
| Subtotal | 6,150 | 6,830 | 8,030 |
| Pasture | 1,597 | 1,911 | 2,349 |
| Unenumerated crops | 595 | 688 | 805 |
| Total | 8,342 | 9,429 | 11,184 |

1/ Identified as "miscellaneous" by OBERS.

Irrigated pasture is one of the major uses of irrigated land in the region. It is assumed that irrigated pasture would change proportionately to the change in irrigated hay since both crops are used to support livestock enterprises. It has been recognized that in some cases a degree of competition exists between hay and pasture; however, in the Columbia-North Pacific Region these two crops tend to complement each other.

Unenumerated harvested cropland is that acreage remaining after subtracting the acreages for the eight crop categories and the irrigated pasture from the irrigated harvested cropland and pasture acreage reported in the 1964 Census of Agriculture. This was assumed to remain constant as a fixed percentage throughout the period to 2020. Thus, the unenumerated category acreage projected for 1980, 2000, and 2020 was assumed to be the fixed percentage figure times the acreage for the eight categories plus irrigated pasture. The "unenumerated" category includes important crops such as silage and vegetable seed which are not included in the other categories. Silage is an important livestock feed; and vegetable seed production in the region, though not an extensive acreage, provides a large part of the Nation's needs.

## Nonagricultural Irrigation Needs

Columbia-North Pacific economic projections predict an increased wood fiber demand and a downward trend in the forest land base (Appendixes VI and VIII). This means there is a need for significant increases in wood fiber yields from the forest lands of the region. In Appendix VIII it has been determined that present timber growth rates are only 65 percent of present industrial wood demand regionwide. By 2020 this difference will increase to the point that growth is only 52 percent of demand.

One potential method of increasing the production of wood fiber is through the irrigation of forest crops. This method may be useful during the trees' early years to assure survival of young stock on dry or marginal sites. Along with the application of fertilizers, it may also be useful for stimulating height and diameter growth during the sapling and pole stage. When total wood fiber is the main requirement, particularly for pulp species, this could be very successful. Foresters are currently experimenting with fertilizers and irrigation, both to test survival and response to these practices.

It is roughly estimated that perhaps 5 million acres of forest land, regionwide, might respond favorably to irrigation if water were available. Much of this land has been included as potentially irrigable. This estimate is based on soil types, climate, slope, and the potential response of various tree species. Ownership

is about equally divided between public and private forest lands. This 5 million acre figure represents the low end of the range of forest lands suitable to irrigation and does not include economic or other feasibility considerations. It does point out, however, that a significant potential does exist for this type of irrigation.

Total Irrigated Area

The irrigated area was developed from the irrigated cropland harvested and pasture acreage by adding nonharvested cropland and other nonproductive or nonagricultural categories of land uses which constitute an irrigated area. This is identified as "other" on table 10 and is estimated to be 15 percent of the irrigated area.

Table 10 - Irrigated Area Needed by 1980, 2000, and 2020, Columbia-North Pacific Region

| Item | Irrigated Acreage 1980 | Irrigated Acreage 2000 | Irrigated Acreage 2020 |
|---|---|---|---|
| | (1,000) | (1,000) | (1,000) |
| Harvested cropland and pasture | 8,342 | 9,429 | 11,184 |
| Other 1/ | 1,471 | 1,663 | 1,975 |
| Special forest uses | (20) | (41) | (53) |
| Rangeland | (10) | (19) | (36) |
| Irrigated area outside economic region 2/ | 287 | 308 | 341 |
| Total Irrigated Area | 10,100 | 11,400 | 13,500 |

1/ Includes irrigated forest nurseries and seed orchards, range, rights-of-way, ditches, roadways, farmsteads, recreation sites, urban, and idle irrigated lands not used in the production of projected crop requirements.

2/ Irrigated areas in Subregions 4 and 5 that are within the hydrologic boundaries but not within the economic boundaries.

Since the economic region contains less acreage than the hydrologic region, a further adjustment was necessary. This refinement is identified as the irrigated area outside the economic region. Therefore the total irrigated area figure represents the irrigated acreage within the hydrologic region needed to meet projected food and fiber requirements. It is the basis for estimating water needs.

## Water

An additional 20 million acre-feet of water will need to be delivered to meet supplemental and full supply needs by 2020. About 93 percent of this water would supply new lands; the remainder would provide an adequate water supply to the two million irrigated acres presently having an inadequate supply.

Depletions resulting from the new water supply will total about 14 million acre-feet. Estimated farm deliveries and depletions are shown by time periods in table 11.

Table 11 - Projected Farm Deliveries and Depletions[1/]
Columbia-North Pacific Region

| Year | Presently Irrigated Farm Delivery | Presently Irrigated Depletion | Future Irrigation Farm Delivery | Future Irrigation Depletion | Total Farm Delivery | Total Depletion |
|---|---|---|---|---|---|---|
| | (All Figures Million Acre-Feet) | | | | | |
| 1966 | 21.0 | 15.4 | | | 21.0 | 15.4 |
| 1980 | 22.1 | 16.1 | 8.2 | 6.2 | 30.3 | 22.3 |
| 2000 | 22.2 | 16.0 | 12.1 | 9.0 | 34.3 | 25.0 |
| 2020 | 22.2 | 15.7 | 18.7 | 13.9 | 40.9 | 29.6 |

1/ Includes water needed for range land and special forest uses.

### Supplemental

Presently irrigated lands experience shortages averaging about 2.2 million acre-feet annually. However, a part of this overall regional shortage will be met by increasing farm efficiencies and by decreasing conveyance losses in existing distribution systems. Furthermore, some additional water will be available in Subregion 2 when the water table in the Columbia Basin Project area stops rising. At that time, the return flows presently going into ground water will begin returning to surface sources, thus decreasing the depletions for presently irrigated lands. In order to meet supplemental needs by 2020, it is expected that farm deliveries will increase by 1.2 million acre-feet annually on the presently irrigated land and that depletions will increase by 300,000 acre-feet. The estimated changes in farm deliveries and depletions are shown by time periods in table 11.

Full

To meet projected needs, approximately 6 million acres of presently dry land must be irrigated in the region by 2020. Required farm deliveries and resulting depletions are shown in the subregional sections of this appendix.

Water requirements for future irrigation were estimated from unit requirements and projected new irrigated acreages. Farm delivery requirements are expected to total 18.7 million acre-feet by 2020 and resulting depletions will amount to 13.9 million acre-feet. These future needs are shown by time periods in table 11. The estimated unit farm delivery requirements and depletions for new lands to be irrigated before 2000 are shown graphically by subareas on figure 5. Specific subareas are identified in the subregional sections of this appendix.

Unit requirements for new lands to be irrigated before 2000 are based on generalized cropping, assuming that a large proportion of the land will be devoted to forage and livestock. Farm and distribution system efficiencies are based on current estimating procedures and are expected to be considerably higher than on the presently irrigated lands.

New lands to be irrigated between 2000 and 2020 will have higher crop water requirements which will be needed to attain expected increasing crop yields. However, with the increasing demand for water, it is expected that overall efficiencies will increase. Therefore, unit requirements will be about the same as for new lands to be irrigated before 2000.

Because of differences in elevation and climate, unit irrigation water requirements vary considerably over the region. Requirements are lowest along the northern Washington coast because of greater precipitation and more cloudy days. They are low in the upper valleys of most stream systems because of lower temperatures, shorter growing season, and greater precipitation than in the lower valley areas. The highest requirements are estimated for the lower lands along the Columbia River which have higher temperatures and are far enough upstream to be effected only slightly by the more humid marine-type climate which occurs west of the Cascades.

As more land is brought under irrigation the trend toward sprinkler irrigation will be accelerated, primarily because of a need for increased efficiency. It is estimated that sprinkler systems will be used on nearly half of the irrigated lands by 1980, 64 percent by the year 2000, and on three-fourths of the irrigated lands by 2020. Factors contributing to this trend include the scarcity of unappropriated surface water, the need for reducing labor costs, and the necessity of developing new land of poorer

relative quality. With sprinkler irrigation the farmer can irrigate: (1) shallow soils, without disturbing the topsoil by land leveling; (2) steep lands, without creating problems of excessive runoff and soil erosion; and (3) sandy lands, without causing excessive moisture loss through deep percolation.

Delivery requirements for nonagricultural irrigation water amount to 62,000 acre-feet in 1980; 110,000 acre-feet in 2000; and 158,000 acre-feet in 2020. Most of this will come from independent surface and ground water sources.

Water requirements for the estimated 5 million acres of potentially irrigable forest land would amount to 8 to 10 million acre-feet annually based on an application rate of 1.5 acre-feet per acre per year. Development of these supplies would probably be in the form of small impoundments in the upland watersheds. Many impoundments would be required because they would be relatively small in size.

## Problems Associated with New Irrigation

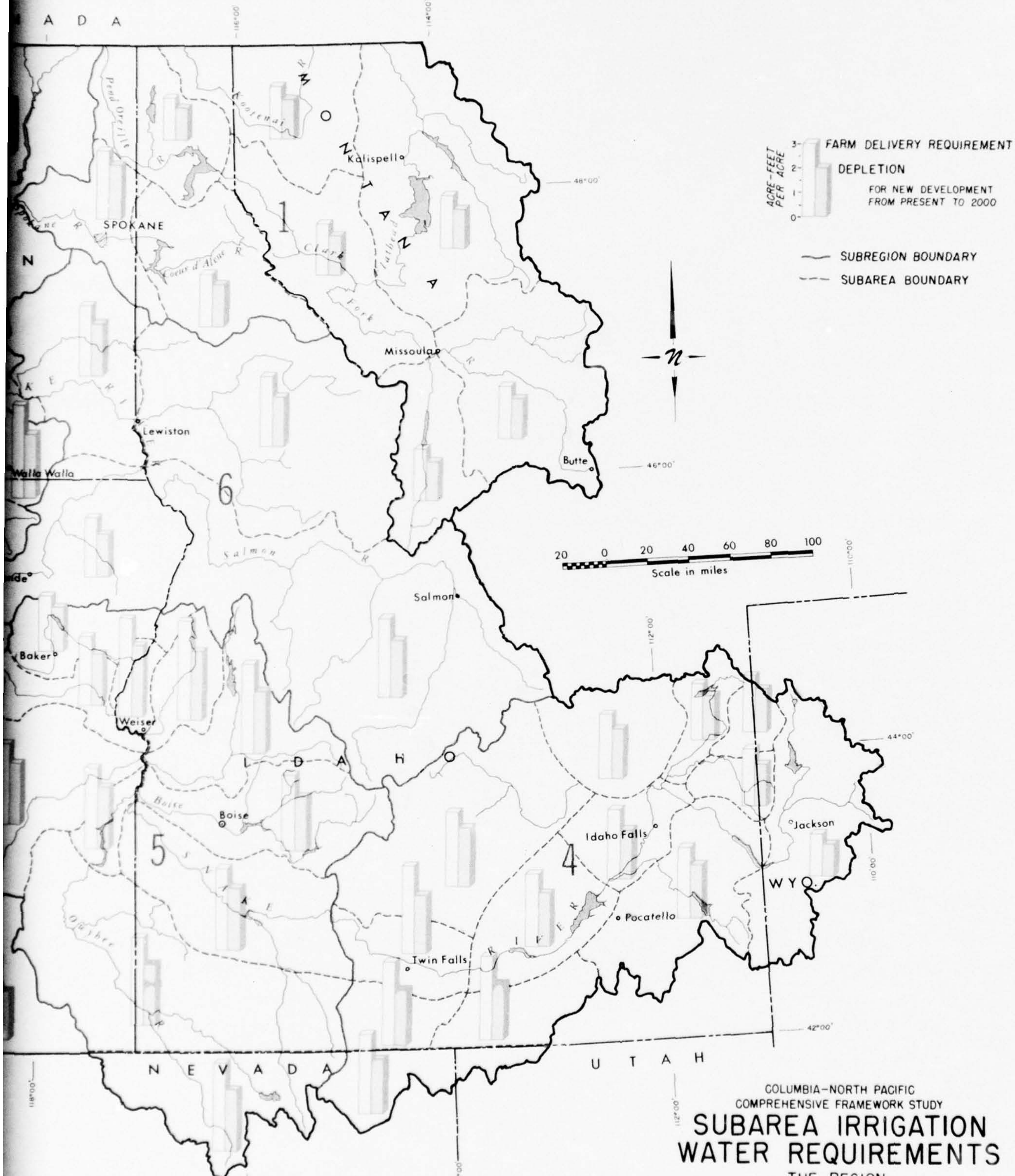
Some of the problems associated with present irrigation will be aggravated with future development, but others will be reduced. Water-right problems, drainage problems, erosion on steeper lands, controversy over the best use of water, and competition for capital needed to develop irrigation projects are prime problems associated with future irrigation development in the region. The difficulties involved in presently complex water management will be further complicated by increased demand for the water. Some of the existing localized problems, on the other hand, such as declining water tables and low late-season streamflows in tributary areas, will be alleviated by the development of new water supplies through water transfers, exchanges or new storage.

With irrigation, considerable acreage of irrigable land will have wetness problems caused either by poor internal drainage characteristics of the soil or by inadequate drainage outlets. Drainage works and improved soil and water management practices will be necessary to solve the wetness problem. Flood control structures will also be needed to reduce flood damage to irrigated lands. In addition, proper design and control of irrigated areas to eliminate or minimize the occurrence of insect vector breeding areas are needed.

Claimed entitlements to water for certain Federal lands under a Federal reservation doctrine may sometimes cloud the right of existing users and may prevent accurate planning for future water utilization. As distribution of water for both present and future uses is facilitated through an accurate accounting of

CANADA
WASHINGTON
OREGON
CALIF.
NEVADA
PACIFIC OCEAN
Bellingham
Everett
SEATTLE
TACOMA
Olympia
Hoquiam
Aberdeen
Astoria
Longview-Kelso
Vancouver
PORTLAND
Tillamook
Salem
Newport
Eugene
Coos Bay
Roseburg
Grants Pass
Medford
The Dalles
Bend
Burns
Malheur Lake
Lake Abert
Grand Coulee
Wenatchee
Moses Lake
Yakima
SPOKANE
Lewiston
Walla Walla
Pendleton
La Grande
Baker
Weiser
Boise
COLUMBIA
Skagit R.
Okanogan R.
Yakima R.
Cowlitz R.
Chehalis R.
Quinault R.
Willamette R.
John Day R.
Deschutes R.
Umpqua R.
Rogue R.
Salmon
Owyhee R.
Boise
Pend Oreille R.
Coeur d'Alene R.
Kootenai R.
1
2
3
5
6
7
8
9
10
10
11
12
124°00'
122°00'
120°00'
118°00'
116°00'
48°00'
46°00'
44°00'
42°00'

2




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# SUBAREA IRRIGATION WATER REQUIREMENTS

THE REGION

1969

FIGURE 5

available water supplies, there is a need to determine such reservation claims and to identify the quantities of water which may attach to reserved lands.

Federal Reclamation Law now limits delivery of water to not more than 160 irrigated acres in an individual ownership--320 to a man and wife. Continual changes and improvements in farming practices and technological advancements in farming equipment and related fields are being made. There is growing concern that these changes will result in an increase in the amount of irrigated acreage an individual is permitted to irrigate on Federal Reclamation projects.

Most of the problems of new irrigation development will be associated with the delivery of water. Much of the region's potentially irrigable land is located at considerable distance from dependable surface water sources and at higher elevation. Extensive and expensive water delivery systems will be required, as will reservoirs to store surface flows. Flows in many of the streams can often meet the early season irrigation demands placed on them, but as the crop season progresses available surface waters dwindle.

An increase in irrigation water demands accompanying increasing recreational, fishery, and industrial and municipal demands will increase conflict over water use in the future. Interest in water-related recreation is high throughout the region. A major portion of the recreational attraction lies in its lakes, reservoirs, and streams. An expanding population will continually require the use of both presently irrigated and potentially irrigable lands for nonagricultural purposes such as roadways and buildings. In addition, farmland within areas of urban expansion is made uneconomical to farm because of increasing property values and taxes.

The water-related recreation resources near population centers are receiving increasing pressure. This pressure has already produced sharp controversy over the best use of certain reservoirs--with some recreationists opposed, for example, to drawdown of reservoirs for irrigation use. As the population grows and the demand for water increases, water utilization will need to be carefully planned and coordinated.

One of the most pressing problems associated with future development will be to provide a full water supply to the presently inadequately irrigated lands. Projections of future irrigation are based on meeting supplemental needs by 2020.

Other problems are unique to various physiographic areas of the region. For discussion purposes the region is separated into the coastal, intermountain, and broad valley and plateau areas.

### Coastal Areas

There are problems associated with storage that are peculiar to the coastal strip of Oregon and Washington. Since development of much of the storage potential on coastal streams would interfere with the migration of anadromous salmonoid fish, and hence, their production, fishery interests generally oppose project construction. Beyond this, the steep gradient in the upper reaches of most coastal streams restricts the number of good dam and reservoir sites. Only a few coastal areas have known ground water resources capable of supporting more than scattered irrigation.

### Intermountain Areas

In the smaller intermountain basins of western Oregon and Washington and northern Idaho and Montana, a major problem associated with government-financed irrigation development will be the competition with other programs for Federal and state money. Irrigation projects are costly because of the scattered nature of irrigable lands. Development might be limited by the availability of ground water and by irrigation season natural streamflows. Other new irrigation problems will be isolated and in general associated with storage facilities and depletions of the lesser tributary streams.

### Broad Valley and Plateau Areas

Problems associated with new irrigation development in the broad valley and plateau areas range from ground water withdrawal and streamflow control in the Snake River Plain to erosion control in the Palouse area of eastern Washington and to water supply and water quality problems in the high desert area of southeastern Oregon.

Some land areas on the Snake River Plain will be irrigated from ground water, and large withdrawals from this source will also be required for irrigation in nearby areas. Localized drawdown of the Snake Plain ground water table may occur but should not be severe. A serious decline in the water table of local aquifers in the Raft River and Goose Creek basins south of the Snake River, however, prompted the State of Idaho to declare these as critical ground water areas, and further development has been temporarily

restricted. New irrigation in these basins will require importing water to stabilize the local ground water table.

However, as consumptive use increases summer streamflows will be substantially depleted. Downstream users pumping from the river may have to relocate their pumps or do rechannelization work, water temperatures will increase somewhat, and other problems related to the reduction of flows will be aggravated.

One of the region's areas of potentially irrigable lands is located in the Palouse area of eastern Washington. Since the deep soils of the loess-covered Palouse Hills produce large volumes of sediment, any storage developed in this area will have to contend with large sediment accumulations unless erosion is controlled on all cropland.

Water shortage, short growing season, and water that is occasionally of poor quality are factors which are likely to continue to deter irrigation expansion in the arid areas of southeastern Oregon and along the Idaho-Nevada border. These areas have a more limited water supply than do most areas of the region. Even with construction of more water storage facilities, much of the potentially irrigable land could not be supplied from the surface water resources. Poor water quality will continue to be a hindrance locally to irrigation development. Waters of the lakes which lack outlets are too saline for irrigation use and in a few areas potentially toxic quantities of boron and sodium salts appear in the ground and spring waters.

## THE POTENTIAL TO MEET THE NEEDS

Potentially irrigable acreage data and maps have been developed through the cooperative efforts of Federal and state agencies concerned with the land resource utilization. All available data have been used to the extent practical; several state-sponsored studies aided materially in determining the irrigation potential for various areas.

### Potentially Irrigable Lands

More than 7 million acres in the region are presently irrigated. Nearly 33 million acres, representing about 19 percent of the total Columbia-North Pacific land area, are classified as potentially irrigable. Table 12 presents these irrigable lands by classes on a subregional basis; table 13 presents the same acreages by states.

Potentially irrigable lands have favorable soil, topography, and drainage characteristics which make them suitable for irrigation.

Table 12 - Potentially Irrigable Land by Subregion
Columbia-North Pacific Region

| | Class 1 (acres) (%) | Class 2 (acres) (%) | Class 3 (acres) (%) | Potentially Irrigable (acres) | % of Total |
|---|---|---|---|---|---|
| Subregion 1 | 110,900 (4) | 645,800 (26) | 1,753,700 (70) | 2,510,400 | 8 |
| 2 | 451,200 (15) | 1,116,800 (38) | 1,403,500 (47) | 2,971,500 | 9 |
| 3 | 60,100 (9) | 262,400 (42) | 309,400 (49) | 631,900 | 2 |
| 4 | 717,200 (16) | 1,797,200 (40) | 1,572,600 (35) | 4,462,900 1/ | 13 |
| 5 | 463,200 (9) | 1,443,200 (29) | 2,415,200 (48) | 5,056,100 1/ | 15 |
| 6 | 170,700 (5) | 1,067,500 (32) | 2,082,000 (61) | 3,391,100 1/ | 10 |
| 7 | 692,400 (12) | 2,360,400 (41) | 2,672,400 (47) | 5,725,200 | 17 |
| 8 | 68,400 (12) | 138,800 (25) | 351,500 (63) | 558,700 | 2 |
| 9 | 318,400 (21) | 528,500 (35) | 655,900 (44) | 1,502,800 | 5 |
| 10 | 117,800 (7) | 594,100 (37) | 911,800 (56) | 1,623,700 | 5 |
| 11 | 29,300 (2) | 218,000 (14) | 1,272,300 (84) | 1,519,600 | 5 |
| 12 | 165,000 (6) | 570,900 (19) | 2,198,500 (75) | 2,934,400 | 9 |
| Total | 3,364,600 (10) | 10,743,600 (33) | 17,598,800 (53) | 32,888,300 | |
| Rounded | (3,400,000) | (10,700,000) | (17,600,000) | (33,000,000) | |

1/ Contains 375,900 acres (9%), 734,500 acres (14%), and 70,900 acres (2%) of land for subregions 4, 5, and 6 respectively. These are designated by the Bureau of Land Management as "other" lands, and do not generally meet Columbia-North Pacific land classification specifications.

Table 13 - Potentially Irrigable Land by States
Columbia-North Pacific Region

| State | Class 1 (acres) | Class 2 (acres) | Class 3 (acres) | Other (acres) | Total (acres) | % of Total |
|---|---|---|---|---|---|---|
| Idaho | 1,152,900 (13) | 3,306,300 (39) | 3,454,700 (40) | 683,800 (8) | 8,597,700 | 26 |
| Montana | 29,700 (2) | 157,500 (13) | 1,050,300 (85) | - | 1,237,500 | 4 |
| Nevada | 17,900 (2) | 150,400 (21) | 505,100 (70) | 49,500 (7) | 722,900 | 2 |
| Oregon | 1,014,200 (9) | 3,979,600 (34) | 6,362,700 (53) | 448,000 (4) | 11,804,500 | 36 |
| Utah | 0 (-) | 13,200 (52) | 12,400 (48) | - | 25,600 | - |
| Washington | 1,145,300 (11) | 3,126,700 (30) | 6,160,300 (59) | - | 10,432,300 | 32 |
| Wyoming | 4,600 (7) | 9,900 (15) | 53,300 (78) | - | 67,800 | - |

*Many millions of acres in the Region similar to these located in the desert southeast of Boise, Idaho, have potential for irrigation development. (Bureau of Reclamation)*

Lands have not been excluded because of climatic limitations except in high, mountainous areas. Lands defined as potentially irrigable are neither presently irrigated nor has it been determined that they can be provided with a water supply economically. Included as potentially irrigable are lands now dryfarmed as well as forest and rangelands that could, with irrigation, produce higher yields or provide a wider range of crop use. Although these lands were evaluated on the basis of their suitability for irrigated cropland, some may be better adapted for wildlife habitats, range forage production, and recreation or scenic areas.

Land classification specifications developed by state and Federal agencies involved in irrigability surveys were used as a guide for mapping all nonirrigated lands in the region. The standards consider the physical limitations of soil, topography, and drainage, and generally reflect the characteristics of irrigated land in the region.

Three potentially irrigable classes--classes 1, 2, and 3--were recognized which meet these specifications; a fourth class, designated as "other," was also recognized but does not generally

meet the criteria of these standards. The standards are shown in table 14.

## Land Classification

Approximately 31.7 million acres have been identified as potentially irrigable and placed in the three land classes. Under irrigation these lands would be suited for the production of climatically adapted agricultural crops, although in some cases they may have greater potential for nonagricultural uses. An additional 1.2 million acres are in an "other" potentially irrigable category. Under irrigation these "other" lands would be primarily suited to producing limited forage for wildlife and livestock grazing since they are not generally suitable for more intensive uses.

Nearly half of the potentially irrigable lands in the region--more than 14 million acres--were placed in classes 1 and 2. Under irrigation, they would be suited to the production of a wide variety of climatically adapted crops and can be farmed and irrigated by modern equipment and methods. These lands are generally suited for gravity methods of irrigation.

Class 3 and "other" lands are of only fair to marginal quality for irrigation development, being limited in both crop productivity and land use. Class 3 lands will generally be limited to sprinkler irrigation; other land, irrigated for grazing, may best be irrigated by wild flooding or a form of water spreading.

The relative physical quality of land is observed to be closely associated with relative irrigation productivity based on climatic factors and the availability of a water supply. The percentage of higher quality soil is greater in areas that have more favorable climatic conditions because of the effect of climate upon soil development. Conversely, the high plateau areas of eastern Oregon, southern Idaho, and adjacent states in the upper parts of the drainage basins, which have limited water supplies and shorter growing seasons, have a significantly higher proportion of class 3 and "other" land.

The locations of the potentially irrigable lands by land classes are shown on subregion maps, and the results of the irrigability survey are shown by subregion in table 12 and by state in table 13. The following discussion describes the features of the irrigable classes.

Class 1 Lands of class 1 quality total nearly 3.4 million acres and represent about 10 percent of the potentially irrigable land. Most of these lands are located on alluvial and windblown

Table 14 - Land Classification Specifications 1/
Columbia-North Pacific Region

| Soil or Land Characteristics | Class 1 2/ Only Slight Limitations | Class 2 2/ Moderate Limitations | Class 3 2/ Severe Limitations |
|---|---|---|---|
| Texture of root zone | Fine sandy loam to friable clay loam | Loamy sand and permeable clay | Loamy sand and clay (sands with sufficient water-holding capacity can be included) |
| Depth to: Clean sand, gravel and cobble; impermeable sediments, or hard rock; hard pan or caliche | 40" plus<br>Note: If hard pan can be modified by deep tillage, it should be rated less severely. | 20-40" | 10-20" |
| Textural Modifiers | | | |
| (Vol.) of tillage layer: Gravel (< 3") Cobble (3-10") | No problem in tillage | 15-20%<br>10-25% | 50-70%<br>25-50% |
| Stoniness of surface and tillage layer | No problem in tillage | Cultivation not impractical (class 1 - Soil Survey *Manual, p. 217)* | Cultivation impractical unless cleared (class 2 - S.S. Manual p. 217) |
| Rockiness (small outcrops within soil type) | No problem in tillage | ≈2% of surface | 2-10% of surface (class 1 - S.S. Manual) |
| | In areas where use has demonstrated suitability, more severe modifiers can be rated irrigable for special uses not requiring tillage. | | |
| Available water-holding capacity (to a maximum depth of 4 feet) | > 6" | > 4-1/2" | > 3" |
| Permeability | Moderately slow to moderately rapid | Slow and rapid | Very slow and very rapid |
| Sodium and alkalinity | < 10% slick spots in complex | 10 to 25% slick spots in complex or saline-alkali conditions with exch. sodium up to 15% | 25-50% slick spots in complex or saline-alkali conditions with exch. sodium 15% |
| | | Topography | |
| Slope | Generally < 4%, may vary from 3 to 5% | Generally < 12%, may vary from 10 to 15% | Generally < 20%, may vary from 15 to 25% |
| | | Drainage | |
| Water table | Easily maintained below major rooting depth during growing season | Practical to maintain below rooting depth most of time in growing season (requires drainage) | Can maintain below 18" most of growing season |
| Overflow | No overflow | Free of overflow in growing season | Overflow may be hazard to crops in some years (2 or 3 in 10) |
| Depth to impermeable barrier | > 8 feet<br>Note: Applies in physiographic positions with problem potential; i.e., basins, fans, pediment slopes, etc. | > 6 feet | > 6 feet |

1/ Cited values are maximum limitations.

2/ Suitable for gravity-type irrigation. Most class 3 lands suitable only for sprinkler irrigation. Any one severe deficiency below the limits of a class is cause for downgrading to next lower class. Two or more such deficiencies are cause for downgrading two classes if judgment indicates they are additive in effect. Combinations of less severe deficiencies will be evaluated on a judgment basis.

Some lands that do not meet the minimum criteria for class 3 may have irrigation potential for certain specialized uses because of climatic setting or position, etc. These may be placed in a specialty class on a judgment basis.

plains on relatively smooth slope of less than 4 percent in general gradient.

These lands are of excellent quality for irrigated agriculture and in all respects are suitable for sustained production of all climatically adapted crops. The soils are deep, well drained, medium textured, and easily worked. The water-holding capacity is excellent, exceeding 6 inches of available moisture in the soil profile. No restrictive horizons occur in the profile and there are no surface cobble or rock which will interfere with cultivation.

Class 2 Class 2 lands represent about one-third of the potentially irrigable land in the region and total nearly 11 million acres. These lands occur commonly at higher elevations than class 1 lands where soils may be shallower; in windblown areas where a significant amount of coarser material has accumulated; or in low-lying areas which may be subject to moderate drainage or flooding problems. Class 2 lands are normally found in association with class 1 lands. Under irrigation these lands are of fairly good quality and capable of profitable production of most climatically adapted crops. These lands have deficiencies which slightly affect their crop adaptability or yield or increase production costs.

Class 3 These lands total about 17.6 million acres in the region or 53 percent of the potentially irrigable land. Class 3 lands are of fair to poor quality for irrigation farming. They have rather serious deficiencies which will limit their crop adaptability, restrict their yield potential, or significantly increase production costs. Under irrigation these lands will require special management to protect against erosion, waterlogging, or other hazards.

Class 3 lands occur at higher elevation on rough, steep slopes; in windblown areas where soils are shallow or sandy; or in areas subject to considerable drainage problems. Most of these lands are found in association with nonarable lands.

Other Nearly 1.2 million acres, about 4 percent of the region's potentially irrigable land, were placed in the "other" potentially irrigable category. These lands are not generally suited for a sustained irrigated agriculture because of severe soil, topographic, or drainage limitations. Under irrigation they would provide limited forage production for wildlife and livestock grazing.

Many of the "other" lands are located on the higher plains areas of the Snake River drainage. Characteristically the soils are shallow to caliche, cemented gravels, or basalt, and occurrences of rock outcrop are common. Many of these lands are found on rather complex rolling surface relief in association with nonarable or class 3 lands.

## Water Supply

Surface runoff of the region is estimated to average 278 million acre-feet annually, including 54 million acre-feet entering from Canada. This runoff reflects surface depletions of 12 million acre-feet and ground water depletions of 2 million acre-feet. There are approximately 550 million acre-feet in ground water storage that contribute about 100 million acre-feet annually to surface flows and ground water withdrawals.

Water supply information is summarized very briefly from the Water Resources Appendix, from which more detailed data can be obtained. Water supply figures shown here and in the subregion sections are based on estimated 1970 conditions. The difference in depletions between 1966 (the beginning year for estimating new irrigation water requirements) and 1970 is minor in comparison to the total water supply. The water supply figures are therefore considered to be essentially equivalent to present conditions.

### Surface Water

Of the 278 million acre-feet of annual surface water supplies, 54 million acre-feet enter from Canada and 224 million acre-feet originate within the region. However, available supplies are about two-thirds the average during about every fifth year as shown in table 15 and about half the average during about every twentieth year. These low flow years must be considered in sizing reservoirs to provide future water supplies.

There is enough runoff available in all subregions to meet projected 2020 irrigation needs. Irrigation depletions resulting from meeting supplemental needs and needs of new irrigation expected by 2020 are 14 million acre-feet or about 5 percent of the average available supply. Outflows from each subregion resulting from deducting this projected new depletion are shown in figure 6 for average year flows. Estimated flows remaining for several conditions including not being able to use inflow from Canada, are shown in table 16. Irrigation was the only use considered in developing this table.

### Ground Water

As indicated in the Water Resources Appendix, the region contains roughly 550 million acre-feet of ground water within the top 50 to 100 feet of the water-bearing strata. The greater saturated depth was used to indicate the relative magnitude of ground waters available in areas where the greatest ground water development is expected. A large portion of the ground water in storage is

Table 15 - Available Water Supply and New Irrigation Depletions
Columbia-North Pacific Region

| Subregion | Average Runoff: Originating Within Subregion | Average Runoff: From Upstream Subregions and Canada | Average Runoff: Total Available | Runoff Exceeded 80 Percent of the Time: Originating Within Subregion | Runoff Exceeded 80 Percent of the Time: From Upstream Subregions and Canada | Runoff Exceeded 80 Percent of the Time: Total Available |
|---|---|---|---|---|---|---|
| | (All Figures Million Acre-Feet) | | | | | |
| 1 | 26.2 | 8.9 | 35.1 | 18.8 | 7.2 | 26.0 |
| 2 | 3.8 | 79.3 | 83.1 | -1.3 1/ | 61.0 | 59.7 |
| 3 | 2.3 | 0 | 2.3 | 1.3 | 0 | 1.3 |
| 4 | 6.2 | 0 | 6.2 | 5.1 | 0 | 5.1 |
| 5 | 5.6 | 6.2 | 11.8 | 3.1 | 5.1 | 8.2 |
| 6 | 21.7 | 11.8 | 33.5 | 14.4 | 8.2 | 22.6 |
| 7 | 10.0 | 118.9 | 128.9 | 6.7 | 83.6 | 90.3 |
| 8 | 18.1 | 156.8 | 174.9 | 12.5 | 106.0 | 118.5 |
| 9 | 27.9 | 0 | 27.9 | 15.7 | 0 | 15.7 |
| 10 | 63.4 | 0 | 63.4 | 41.8 | 0 | 41.8 |
| 11 | 37.7 | .7 | 38.4 | 29.6 | .5 | 30.1 |
| 12 | 1.2 | 0 | 1.2 | .5 | 0 | .5 |
| Total | 224.1 | 53.8 2/ | 277.9 3/ | 148.2 | 42.7 2/ | 190.9 3/ |

1/ Minus figure is caused by diversions and storage use from Columbia River that are greater than the discharge that originates in the subregion. Water from Subregion 1 and from Canada meets a substantial part of the diversions.

2/ Includes only estimated upstream flow from Canada

3/ Includes only Subregions 8, 10, 11, and 12 because these subregions discharge flows outside of the Regional boundary.

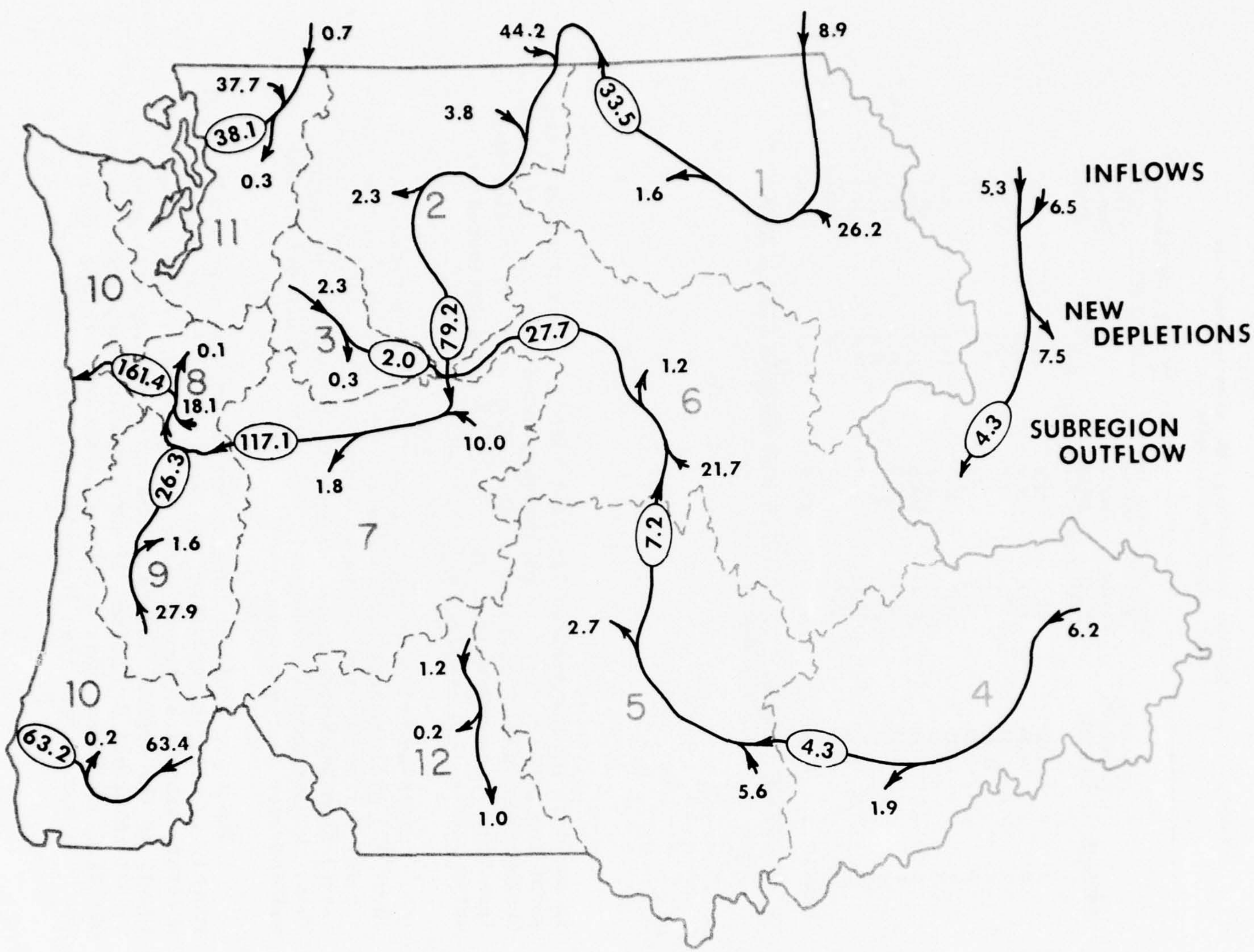



FIGURE 6. Average Year Flows with Proposed 2020 Irrigation Depletions in Millions of Acre-feet

Table 16 - Flows Remaining After Meeting 2020 Irrigation Development
Columbia-North Pacific Region

| Subregion | Additional Irrigation Depletion | Based on Average Runoff: With Canada Water | Based on Average Runoff: Without Canada Water | Runoff Exceeded 80 Percent of the Time: With Canada Water | Runoff Exceeded 80 Percent of the Time: Without Canada Water |
|---|---|---|---|---|---|
| | | (All Figures Million Acre-Feet) | | | |
| 1 | 1.56 | 33.5 | 24.6 | 24.4 | 17.2 |
| 2 | 2.26 | 79.2 | 26.1 | 55.8 | 13.6 |
| 3 | .31 | 2.0 | 2.0 | 1.0 | 1.0 |
| 4 | 1.88 | 4.3 | 4.3 | 3.2 | 3.2 |
| 5 | 2.73 | 7.2 | 7.2 | 3.6 | 3.6 |
| 6 | 1.17 | 27.7 | 27.7 | 16.8 | 16.8 |
| 7 | 1.84 | 117.1 | 64.0 | 78.5 | 36.3 |
| 8 | .14 | 161.4 | 108.3 | 105.0 | 62.8 |
| 9 | 1.64 | 26.3 | 26.3 | 14.1 | 14.1 |
| 10 | .24 | 63.2 | 63.2 | 41.6 | 41.6 |
| 11 | .26 | 38.1 | 37.4 | 29.8 | 29.3 |
| 12 | .21 | 1.0 | 1.0 | .3 | .3 |
| Total 1/ | 14.24 | 263.7 | 209.9 | 176.7 | 134.0 |

1/ Includes only Subregions 8, 10, 11, and 12; these subregions discharge water outside of the Regional boundaries.

in aquifers of low permeability and some is in mountainous areas or at too great a depth to be pumped economically for irrigation. Furthermore, annual recharge in dry valley areas is considerably less than in mountainous areas. Table 17 shows estimated ground water storage and recharge by subregion.

Gross annual recharge to ground water is estimated to be about 123 million acre-feet annually. However, some of the water has moved from surface to ground water two or three times in its travel from headwater areas before finally leaving the region. Thus, the net annual recharge is probably on the order of 100 million acre-feet per year.

The major aquifers have an annual recharge and discharge of roughly 70 million acre-feet. This is a significant resource. However, since most ground water discharge contributes to surface runoff in the region, future ground water pumping will generally result in direct depletions of surface water supplies. Increased use of ground water will utilize this natural storage regulation which is much larger than the potential surface storage.

Table 17 - Ground Water Storage and Gross Annual Recharge
Columbia-North Pacific Region

| Subregion | Storage (Million Acre-Feet) | Gross Annual Recharge (Million Acre-Feet) |
|---|---|---|
| 1 | 69 | 24 |
| 2 | 35 | 6 |
| 3 | 13 | 2 |
| 4 | 100 | 18 |
| 5 | 100 | 5 |
| 6 | 31 | 9 |
| 7 | 47 | 12 |
| 8 | 8 | 6 |
| 9 | 27 | 11 |
| 10 | 27 | 16 |
| 11 | 40 | 11 |
| 12 | 56 | 8 |
| Total | 553 | 123 |

Source: Bureau of Reclamation data.

## Potential Developments

A concentrated and cooperative effort will have to be made by Federal, State, and private entities to meet future irrigation needs. From the present (1966) to 1980 an additional 2.8 million irrigated acres, a 38 percent increase, is needed in the Columbia-North Pacific Region to help meet the projected food and fiber requirements. However, if development proceeds at a rate consistent with the historical trend--roughly 100,000 acres per year--only half of this need can be met. Furthermore, it is estimated that in the 3 years since 1966 a total of 200,000 acres have been brought under irrigation. Thus, to meet its irrigation needs, the Columbia-North Pacific Region must have a decade of unprecedented irrigation development during the 1970's.

From 1980 to 2020 an estimated additional 3.4 million acres will have to be developed to meet food and fiber needs. This means that new irrigation development will have to continue at a rate roughly equal to the present historical trend.

Most of the more readily developable land has been brought under irrigation; only a few areas remain where it would be possible for a private individual to economically irrigate. To meet most of the future need, high-lift pumping facilities, new storage developments, and elaborate delivery systems will be required. Because

*The impact irrigation has on the landscape is shown in these "before" and "after" photos. What was in sagebrush before supports irrigated corn. Also a new farmstead has been constructed. (Bureau of Reclamation)*

the tremendous costs associated with developing these facilities is beyond the means of the private individual, Federal, State, and large corporate financial assistance will be required. A discussion of the role public and private interests are expected to play in this irrigation development is presented in the subregion portions of this appendix.


LOCATION MAP

# SUBREGION 1

# S U B R E G I O N 1

## C L A R K F O R K - K O O T E N A I - S P O K A N E

### THE SETTING

Located in the northeast corner of the region, the Clark Fork-Kootenai-Spokane Subregion ranks as the second largest in land area. It lies in parts of three states--the northwest portion of Montana contains 70 percent of the subregion; the northern panhandle of Idaho, 21 percent; and the extreme northeast corner of Washington, 9 percent.

The subregion is an area of diverse topography. The primary landforms are mountain ranges, generally trending north-south, which separate rather narrow agricultural valley areas. The majority of the subregion lies within the northern Rocky Mountains; the southwest part of the Spokane River drainage contains portions of the Channeled Scablands and the Palouse Hills.

Three drainage systems--Clark Fork, Kootenai, and Spokane--lie within the subregion. To simplify the handling of the data and for convenience in presenting descriptive material, the subregion has been divided into eight subareas. These subareas are either an entire river drainage basin or a portion of a river drainage basin.

The Clark Fork River system has been divided into the following five subareas: the Bitterroot--those lands drained by the Bitterroot River; the Upper Clark Fork--those lands drained by the Blackfoot River system and the Clark Fork River upstream from Missoula, Montana; the Lower Clark Fork--those lands drained by the Clark Fork River downstream from Missoula, Montana, to Pend Oreille Lake; the Flathead--those lands drained by the Flathead River system; and the Pend Oreille--those lands drained by the Pend Oreille River downstream to the International Boundary and those lands around Pend Oreille Lake and Priest Lake.

The Kootenai area consists of the entire Kootenai River drainage in Idaho and Montana.

Two subareas make up the Spokane River drainage--the Upper Spokane, which encompasses all those lands upstream from Spokane, Washington, including those around Coeur d'Alene Lake and along the Coeur d'Alene River; and the Lower Spokane, which includes lands downstream from Spokane to the Columbia River.

Figure 7 shows the location of the eight subareas.


FIGURE 7. Subareas in Subregion 1, Clark Fork, Kootenai, Spokane.

Precipitation in the lowland portions of the Lower Spokane subarea ranges from 15 to 20 inches annually, with most occurring during the cool season. The Pend Oreille, Upper Spokane, and the western portions of the Kootenai and Lower Clark Fork subareas are in the "rain belt" of the subregion where annual moisture amounts range from 20 to 60 inches. The lowlands in the Flathead, Upper Clark Fork, Bitterroot, and eastern portions of the Lower Clark Fork and Kootenai subareas generally average from 10 to 20 inches of precipitation annually.

Temperatures throughout the subregion reflect the inland location and topography of the land. Average July temperatures range from 60°F. to 70°F. and average January temperatures range

from 15°F. to 30°F. The average annual temperature range is about 50°F. and the frost-free period ranges from 80 to 190 days.

More than 60 percent of the 23,271,000-acre land area is in public ownership. Over 80 percent is forested. These two factors have played an important role in the settlement and development of the subregion. Initial efforts at settlement in the Columbia-North Pacific Region occurred in this subregion during the period 1809-1811. Early economic activities were centered around lumbering and mining. The coming of the railroads and the many grants and Acts helped to open the country and soon other activities including agriculture were important to the subregion. These three activities, together with recreation, are important to the present economic picture for Subregion 1.

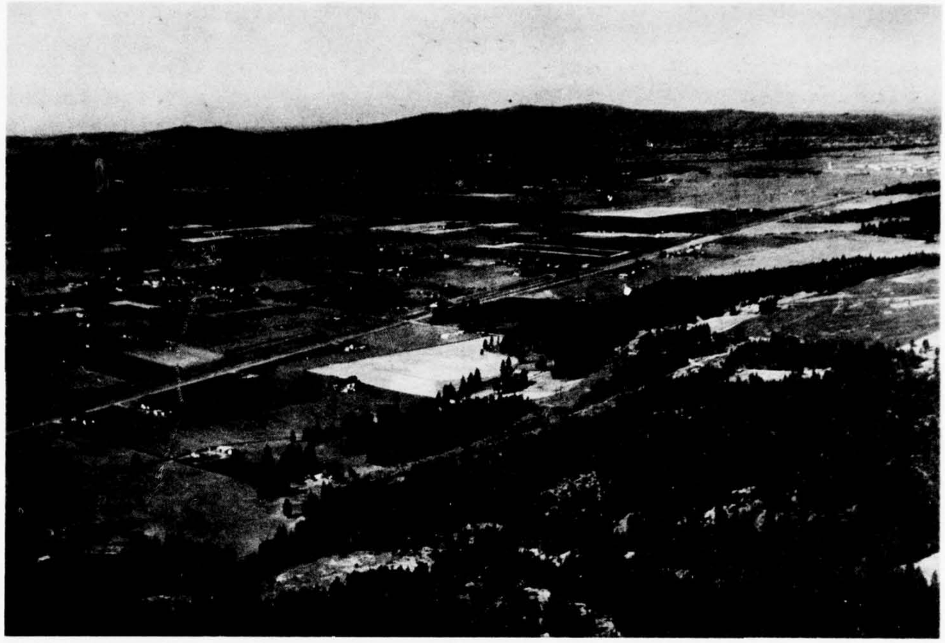
More than 580,000 people inhabit the subregion, ranking it third in the region. Most are centered in the major cities, including Spokane, Washington; Missoula and Kalispell, Montana; and Coeur d'Alene, Idaho. Many areas of the subregion are sparsely populated.

Railroads, an excellent network of highways, and commercial airlines serve the subregion. Spokane, Coeur d'Alene, Sandpoint, Kalispell, and Missoula are important trade, service, and processing centers.

Agricultural lands are located in each subarea. Generally these lands are concentrated in the many valleys. Higher elevations are used extensively for livestock grazing. Heaviest concentrations are in the Upper Spokane, Lower Spokane, Flathead, Upper Clark Fork, and Bitterroot subareas.

The diversity and dependability afforded agriculture through the use of irrigation soon became apparent to the farmers in the subregion. The first irrigation ditch in Montana, and in the subregion, was built by the Stevensville Mission near present-day Hamilton (Bitterroot subarea) in 1842. Development proceeded slowly and in scattered areas until the advent of the railroads initiated an era of settlement throughout the subregion that lasted through the early 1900's. Irrigation development began near Saint Ignatius, Montana, (Flathead subarea) in 1854, near Missoula, Montana (Bitterroot subarea) in 1864, and near Kalispell, Montana, (Flathead subarea) in 1885. In the Upper Spokane subarea, extensive irrigation works were developed between Spokane, Washington, and Coeur d'Alene, Idaho, from 1900 to 1910. All of these initial irrigation developments were privately financed and constructed.

Federal investigations were undertaken in 1907 and 1908 to begin irrigation development of lands in the Flathead Indian Reservation located south of Flathead Lake. Irrigation water was

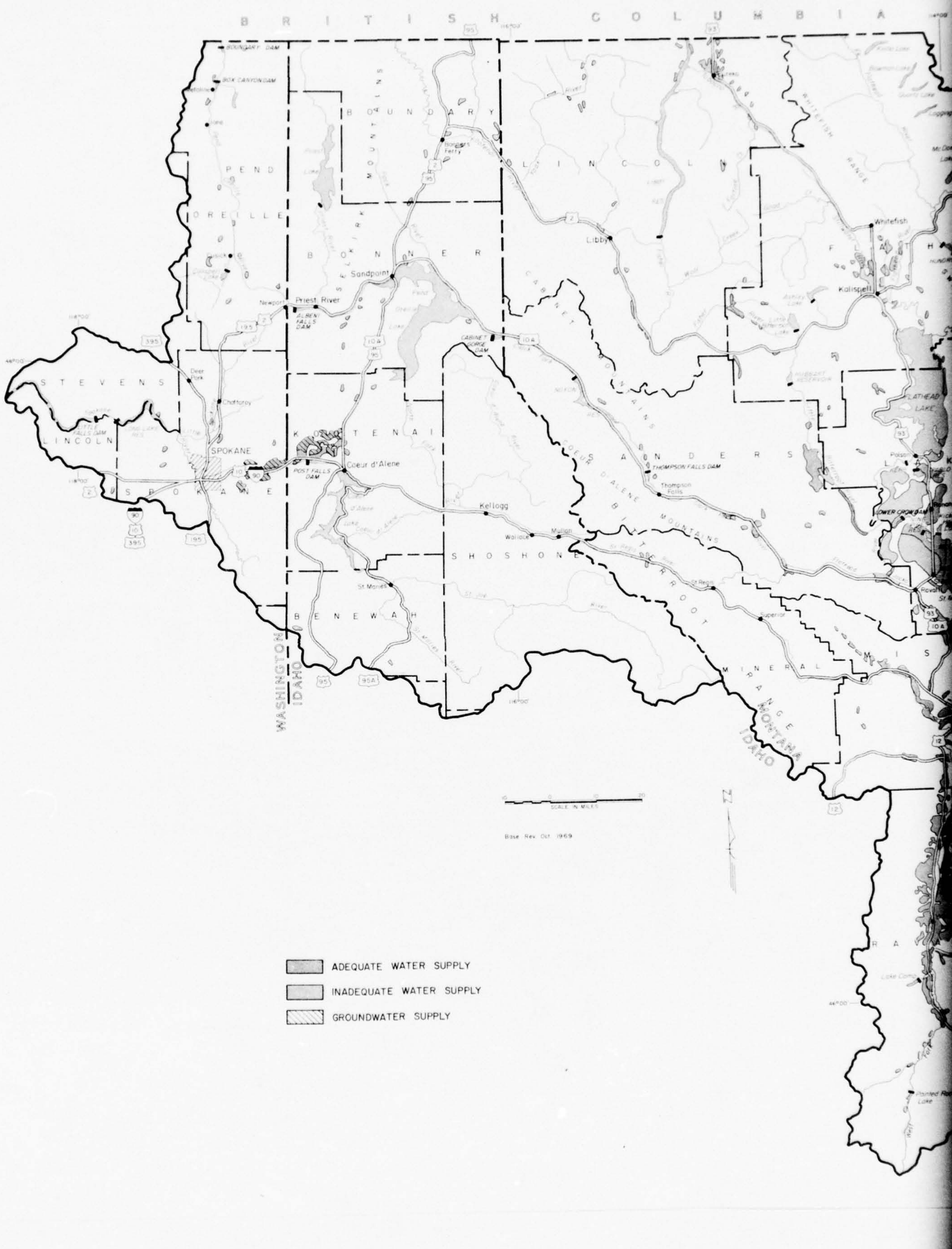


*Irrigated lands east of Spokane, Washington, in the Upper Spokane area. (Bureau of Reclamation)*

made available in 1911. Further development continued under the Reclamation Service until 1924 when jurisdiction was transferred to the Bureau of Indian Affairs. In 1930 the Bureau of Reclamation rehabilitated facilities of the Bitter Root Irrigation District in the Bitterroot subarea; further rehabilitation was undertaken in 1936, 1948, and 1956. In 1935 the Bureau of Reclamation constructed the Frenchtown Project near Missoula and in 1939 constructed the Big Flat Unit of the Missoula Valley Project. The next phase of Federal development occurred in the 1940's and 1950's with rehabilitation of private systems in the Rathdrum Prairie section northwest of Coeur d'Alene and in the mid-1960's in the Spokane Valley east of Spokane.

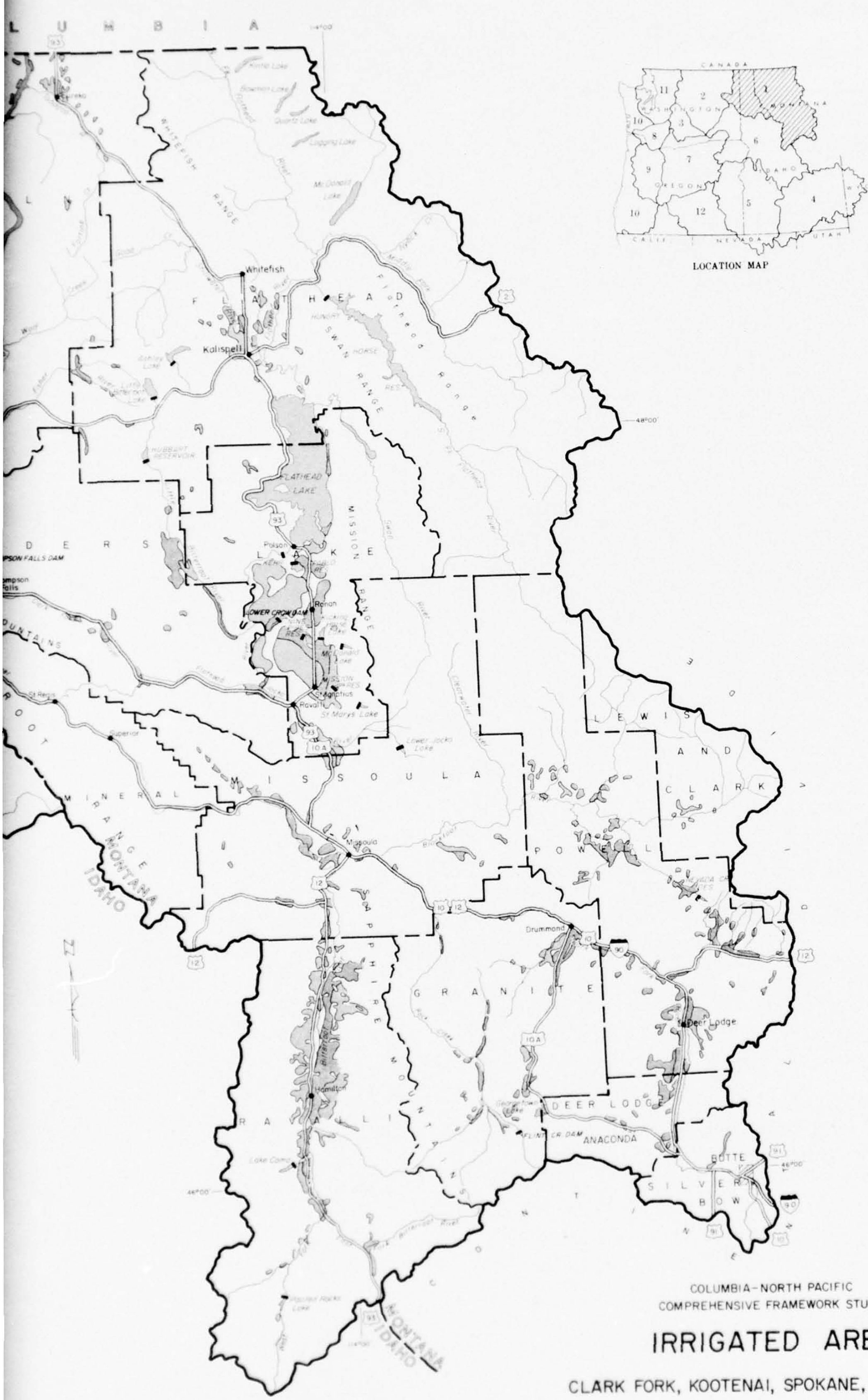
## PRESENT STATUS

The subregion ranked sixth in 1966 with an irrigated area of 480,000 acres under private and Federal development. Included are some 3,100 acres of irrigated forest nurseries and seed orchards, recreation sites, and minor tracts used for wildlife and other purposes. Table 18 lists the irrigated area acreage by source of supply, method of irrigation, and adequacy of supply.



BRITISH COLUMBIA
BOUNDARY
PEND OREILLE
BONNER
LINCOLN
STEVENS
SPOKANE
KOOTENAI
SHOSHONE
BENEWAH
SANDERS
MINERAL
WASHINGTON
IDAHO
MONTANA
Spokane
Coeur d'Alene
Sandpoint
Priest River
Newport
Kellogg
Wallace
Mullan
St Maries
Libby
Whitefish
Kalispell
Thompson Falls
Superior
BOUNDARY DAM
BOX CANYON DAM
ALBENI FALLS DAM
CABINET GORGE DAM
POST FALLS DAM
THOMPSON FALLS DAM
FLATHEAD LAKE
Base Rev. Oct. 1969
SCALE IN MILES
ADEQUATE WATER SUPPLY
INADEQUATE WATER SUPPLY
GROUNDWATER SUPPLY

2




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# IRRIGATED AREA

CLARK FORK, KOOTENAI, SPOKANE, SUBREGION

1968

FIGURE 9

Table 18 - Irrigated Area, 1966, Subregion 1

| State | Source of Supply Surface | Source of Supply Ground | Adequacy of Supply Adeq. | Adequacy of Supply Inadeq. | Method of Irr. Sprinkler | Method of Irr. Gravity | Total |
|---|---|---|---|---|---|---|---|
| | | | (Acres) | | | | |
| Idaho | 13,000 | 11,000 | 24,000 | 0 | 23,000 | 1,000 | 24,000 |
| Montana | 416,000 | 15,000 | 238,000 | 193,000 | 97,000 | 334,000 | 431,000 |
| Wash. | 8,000 | 17,000 | 23,000 | 2,000 | 23,000 | 2,000 | 25,000 |
| Total | 437,000 | 43,000 | 285,000 | 195,000 | 143,000 | 337,000 | 480,000 |

## Characteristics of Irrigated Areas

Of the total area irrigated in 1966, 431,000 acres were in Montana, 24,000 acres in Idaho, and 25,000 acres in Washington. Figure 8 shows the general location of the irrigated areas within the subregion.

Irrigation development is generally concentrated in four subareas--the Flathead, Upper Clark Fork, Bitterroot, and Upper Spokane. These four subareas contain 88 percent of the irrigated land with the remaining irrigated land occurring as smaller, scattered tracts throughout the Lower Clark Fork, Lower Spokane, Kootenai, and Pend Oreille subareas.

The Flathead subarea with 153,000 acres irrigated includes the Flathead Irrigation Project which had 114,000 acres under service in 1966. The project is located entirely within the Flathead Indian Reservation and is the subregion's largest single project-type development. Significant development has also taken place around the city of Kalispell. Agriculture throughout the subarea is based on irrigated forage crop production to support livestock enterprises, small grains, tree fruits (particularly cherries around Flathead Lake), field crops, and some dairying and local vegetable production.

The Upper Clark Fork subarea contains several substantial blocks of irrigated land and a number of smaller scattered developments that total some 131,000 acres. The larger irrigated blocks are located along the main stem of the Clark Fork and Blackfoot Rivers with the remainder located along tributary streams. Irrigated crops include forage crops to support livestock and small grains, potatoes, and dairying to support urban needs.

In the Bitterroot subarea 109,000 acres are devoted to the production of forage crops to support livestock, small grains, field crops such as sugar beets and potatoes, vegetables, and tree fruits including apples and cherries. Various groups of farmers, including organized irrigation districts, account for about one-half of the irrigated acreage. The remaining acreage is under individual ditches.

The Upper Spokane subarea contains the bulk of the irrigated land in the Idaho and Washington portion of the subregion, with virtually all irrigation located in the Spokane Valley-Rathdrum Prairie section. There are 34,000 irrigated acres in the subarea devoted chiefly to forage crops, small grains, tree fruits and berries, field crops, and vegetables.

In addition, there are 29,000 acres of irrigated land in the Lower Clark Fork subarea, 9,000 acres in the Kootenai subarea, 8,000 acres in the Lower Spokane subarea, and 7,000 acres in the Pend Oreille subarea. Two fairly large blocks are located in the Lower Clark Fork subarea--one extending northwest from Missoula and one upstream from Thompson Falls, Montana. The largest area of irrigated land in the Kootenai subarea is in the Tobacco Flats section near Eureka, Montana. The irrigated lands in these four subareas are devoted chiefly to forages and small grains with limited acreages of field crops.

Data presented on characteristics of irrigated farms were derived from the 1964 Census of Agriculture for Benewah, Bonner, Boundary, Kootenai, and Shoshone Counties in Idaho; Pend Oreille and Spokane Counties, Washington; and Deer Lodge, Flathead, Granite, Lake, Lincoln, Mineral, Missoula, Powell, Ravalli, Sanders, and Silver Bow Counties in Montana. According to the Census, there were 3,702 farms with irrigated land in 1964; this number represented about 36 percent of the 10,203 farms in the subregion. The average farm with irrigated land had about 110 acres irrigated. More dairy and other livestock farms had irrigated acreages than any other farm type. On the other hand, the majority of the land devoted to fruit and vegetable crops was irrigated. Field crop farms growing sugar beets, potatoes, mint, and clover seed also had some irrigated acreages. Some cash-grain farms had small irrigated acreages.

Figure 9 shows the amount of irrigated acreage and the relative distribution of land use by major crop categories.

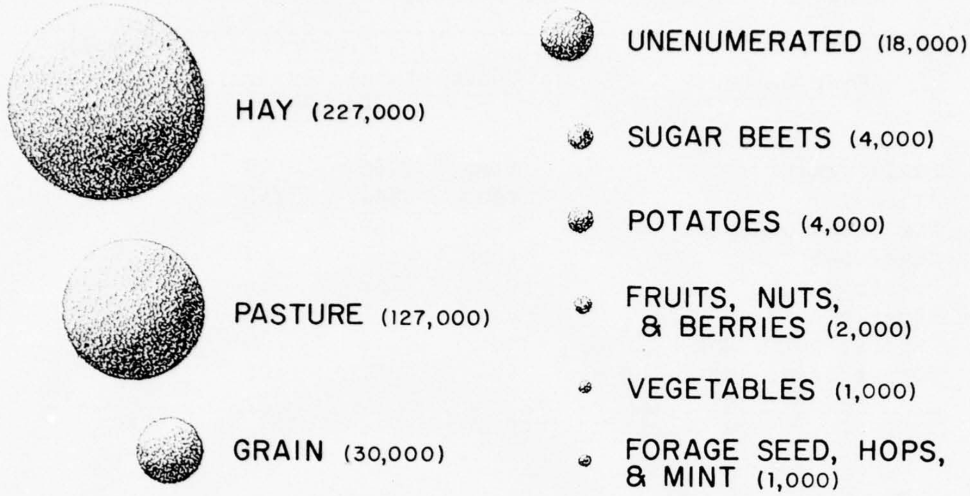



FIGURE 9. Acreage of Irrigated Cropland Harvested and Pasture, 1964, Subregion 1

## Production of Irrigated Crops

The amount of total crop production coming from irrigated land in 1964 is presented in table 19. All of the sugar beets, potatoes, and vegetables produced in the subregion were grown under irrigation. However, these are not major crops in this subregion. On the other hand, nearly 47 percent of all hay production came from irrigated land, which is quite significant since this supports a large livestock industry. Yields of selected major crops are presented in table 20.

Livestock production is of major importance in the agricultural economy of the subregion. Public and private rangelands provide summer grazing for livestock while irrigated and nonirrigable feed crops provide the feed supply for wintering breed stock, fattening market animals, and maintaining those animals producing livestock products. It has been estimated that irrigated feed crops supply slightly over 30 percent of the feed requirements of the local livestock industry.

## Value of Production

The total value of sales of crops, livestock, and livestock products from irrigated land in 1964 was estimated to be $13.9 million for Subregion 1. This consisted of $3.8 million crop

Table 19 - Summary of Crop Production, 1964, Subregion 1

| Crop Category | Units | Production Total (1,000's) | Production Irrigated (1,000's) | Percent Irrigated |
|---|---|---|---|---|
| Small grains | tons | 436 | 29 | 6.7 |
| All hay | tons | 844 | 395 | 46.8 |
| Dry beans and peas | cwt. | 669 | 5 | .7 |
| Sugar beets | tons | 57 | 57 | 100.0 |
| Potatoes | cwt. | 750 | 750 | 100.0 |
| Vegetables | cwt. | 91 | 68 | 75.0 |
| Fruits, nuts, and berries | tons | 5 | 3 | 60.0 |
| Forage seed, hops, and mint | lbs. | 942 | 105 | 11.0 |

Source: Census of Agriculture and Agricultural Statistics.

Table 20 - Yields for Selected Major Irrigated Crops, 1964, Subregion 1

| Crops | Units | Yield Per Acre |
|---|---|---|
| Small grains | | |
| Wheat | tons | 1.29 |
| Barley | tons | 1.18 |
| Oats | tons | .90 |
| Hay | | |
| Alfalfa | tons | 2.50 |
| Other | tons | 1.56 |
| Potatoes | cwt. | 169 |
| Clover seed | lbs. | 200 |

value exclusive of livestock feed and $10.1 million value associated with livestock and livestock products.

## Economic and Social Impacts from Irrigation

Agriculture is an important industry in the subregion's economy and irrigation has increased its value. The gross value of products and services derived from irrigation use is shown in table 21. It is estimated that irrigation use generated economic values more than double the value of sales of irrigated agricultural

production in 1964. Part of this was brought about by the increased volume of agricultural products processed or otherwise handled because of irrigation. The remainder was the result of additional business activity generated by the increased demand for goods and services by farmers, processors, and those businesses serving them.

Table 21 - Gross Value of Agricultural Products and Services Associated with Irrigation Use in 1964, Subregion 1

| Industry | Gross Value ($1,000,000) |
|---|---|
| Basic Agriculture | 13.9 |
| Processing | 11.3 |
| Trades and Services | 22.5 |
| Total | 47.7 |

Agricultural labor needs were greatly increased because of irrigation use. However, labor needs in the processing and trades and services industries were increased even more as a result of irrigation.

## Use of Water

Of the 480,000 acres irrigated in the subregion, 330,000 acres are served by private irrigation systems and 150,000 acres obtain supplies from Federally constructed facilities. Some 437,000 acres are irrigated from surface sources including 117,000 acres that obtain water supplies from storage. The remaining 43,000 acres are served by ground water development--more than 22,000 acres are concentrated in an area between Spokane, Washington, and Coeur d'Alene, Idaho.

Surface water diversions total 1,844,000 acre-feet for 242,000 acres with an adequate supply and 195,000 acres with an inadequate supply as shown in table 22. Return flows from surface diversions amount to 1,183,000 acre-feet annually, resulting in depletions of 661,000 acre-feet.

The entire 43,000 acres irrigated from ground water are adequately supplied with 130,000 acre-feet. Return flows and depletions amount to 61,000 and 69,000 acre-feet respectively. Ground water use is shown by subareas in table 23.

Table 22 - Irrigation from Surface Water Sources, 1966 Level, Subregion 1

| Subarea | Adequate Supply Area (acres) | Adequate Supply Diversion (acre-feet | Inadequate Supply Area (acres) | Inadequate Supply Diversion (acre-feet) | Return Flow (acre-feet) | Depletion (acre-feet) |
|---|---|---|---|---|---|---|
| Bitterroot | 63,000 | 315,000 | 43,000 | 165,000 | 320,000 | 160,000 |
| Upper Clark Fork | 113,000 | 565,000 | 18,000 | 50,000 | 415,000 | 200,000 |
| Lower Clark Fork | 23,000 | 115,000 | 4,000 | 18,000 | 93,000 | 40,000 |
| Flathead | 16,000 | 80,000 | 127,000 | 434,000 | 299,000 | 215,000 |
| Kootenai | 8,000 | 40,000 | 1,000 | 4,000 | 31,000 | 13,000 |
| Pend Oreille | 7,000 | 15,000 | -- | -- | 6,000 | 9,000 |
| Upper Spokane | 11,000 | 33,000 | -- | -- | 14,000 | 19,000 |
| Lower Spokane | 1,000 | 4,000 | 2,000 | 6,000 | 5,000 | 5,000 |
| Total | 242,000 | 1,167,000 | 195,000 | 677,000 | 1,183,000 | 661,000 |

Source: Soil Conservation Service and Bureau of Reclamation data.

Table 23 - Irrigation from Ground Water Sources, 1966 Level, Subregion 1

| Subarea | Adequate Supply Area (acres) | Adequate Supply Diversion (acre-feet) | Inadequate Supply Area (acres) | Inadequate Supply Diversion (acre-feet) | Return Flow (acre-feet) | Depletion (acre-feet) |
|---|---|---|---|---|---|---|
| Bitterroot | 3,000 | 10,000 | -- | -- | 5,000 | 5,000 |
| Upper Clark Fork | -- | -- | -- | -- | -- | -- |
| Lower Clark Fork | 2,000 | 7,000 | -- | -- | 4,000 | 3,000 |
| Flathead | 10,000 | 33,000 | -- | -- | 16,000 | 17,000 |
| Kootenai | -- | -- | -- | -- | -- | -- |
| Pend Oreille | -- | -- | -- | -- | -- | -- |
| Upper Spokane | 23,000 | 65,000 | -- | -- | 29,000 | 36,000 |
| Lower Spokane | 5,000 | 15,000 | -- | -- | 7,000 | 8,000 |
| Total | 43,000 | 130,000 | -- | -- | 61,000 | 69,000 |

Source: Soil Conservation Service and Bureau of Reclamation data.

Surface and ground water diversions, return flows and depletions are shown by states for the 1966 level of development in tables 24 and 25. With total diversions of 1,974,000 acre-feet and return flows of 1,244,000 acre-feet, depletions amount to 730,000 acre-feet annually.

Table 24 - Irrigation from Surface Water Sources by State, 1966 Level, Subregion 1

| State | Irrigated Area (acres) | Average Annual Withdrawal (acre-feet) | Average Return Flow (acre-feet) | Average Stream Flow Depletions (acre-feet) |
|---|---|---|---|---|
| Idaho | 13,000 | 34,000 | 14,000 | 20,000 |
| Montana | 416,000 | 1,786,000 | 1,158,000 | 628,000 |
| Washington | 8,000 | 24,000 | 11,000 | 13,000 |
| Total | 437,000 | 1,844,000 | 1,183,000 | 661,000 |

Table 25 - Irrigation from Ground Water Sources by State, 1966 Level, Subregion 1

| State | Irrigated Area (acres) | Average Annual Withdrawal (acre-feet) | Average Return Flow (acre-feet) | Average Ground Water Depletion (acre-feet) |
|---|---|---|---|---|
| Idaho | 11,000 | 30,000 | 13,000 | 17,000 |
| Montana | 15,000 | 50,000 | 25,000 | 25,000 |
| Washington | 17,000 | 50,000 | 23,000 | 27,000 |
| Total | 43,000 | 130,000 | 61,000 | 69,000 |

## Adequacy of Supply

In the Upper Clark Fork, Bitterroot, and Flathead subareas irrigation has developed to such an extent that natural streamflows are inadequate to supply all of the water needs of the irrigated farms throughout the summer season. Storage facilities have been constructed in these areas to hold spring runoff for release in the late summer months to supplement natural streamflows.

In the Upper Clark Fork subarea, irrigated lands in need of additional water are concentrated in three areas--3,500 acres north of Butte, Montana, that receive water from tributaries of the Clark Fork River; 7,500 acres in the Flint Creek drainage south of Drummond, Montana; and 4,000 acres that receive water from the Blackfoot River or its tributaries. These lands are all in need of varying amounts of additional water during the late summer months.

About 43,000 acres in the Bitterroot subarea experience periodic shortages. These lands are dependent upon the runoff from small tributaries of the Bitterroot River and have water rights junior to the rights held by those lands located nearer to the river. The shortages result when streamflows decline in the late summer months.

*Bitter Root Project, Montana - irrigated forage crops support livestock. (Bureau of Reclamation)*

It is estimated that 127,000 acres are in need of supplemental water in the Flathead subarea. The greatest portion of this land (114,000 acres) is located in or near the Flathead Indian Reservation. As in many other areas in Montana, shortages result when natural streamflows decline in late summer months and stored water is entirely used. When water is available, however, diversions are relatively high. Additional storage is needed to

hold water supplies over into the later part of the irrigation season; however, the additional annual amount of diversion would not have to be increased under the present level of development and present farming and irrigation practices. If an extremely dry period was to occur, it is estimated that these lands could experience shortages as high as 30 percent.

Some 7,600 acres near Kalispell, Montana, in the Flathead subarea have about a 50 percent average water supply. Studies are now underway to find a means of providing the Ashley Irrigation District, which includes the lands experiencing the greatest shortages, with an adequate supply of water.

There are other smaller areas that experience irrigation water shortages scattered throughout the subregion. Overall, it is estimated that 195,000 acres experience significant water shortages in years of critically low runoff. These lands are shown on figure 8.

## Application of Water

Although both gravity and sprinkler methods of application are used, the gravity systems predominate, serving almost 70 percent of the irrigated lands. However, sprinkler application has increased steadily since 1945. The gravity methods, which include wild flooding for pasture and hay crops and corrugations and borders for alfalfa, grain, and forage crops, are employed most widely in Montana. Hand-move sprinkler systems are used almost exclusively by irrigators in the Idaho and Washington portions of the subregion. Much of the more recent irrigation development has taken place in this part of the subregion.

## Quality of Water

The surface waters of the subregion are of excellent quality for irrigation except in some local areas of mine drainage. Discharges of acid mine wastes and tailings from ore concentration mills have degraded water quality in the reach of the Clark Fork River between Butte and Drummond, Montana. This reach was classified for industrial use only until recently when the lower 40 miles were upgraded to include agricultural use as a result of improved waste treatment. Degradation of water quality has also occurred in the Coeur d'Alene River below the mining area near Kellogg, Idaho; however, data are not available on the effect this degradation has had on the quality of water for irrigation.

The ground water resource, although generally more mineralized than surface water, is also suitable for irrigation. The irrigated

lands are generally leached of readily soluble salts. Irrigation return flows do not carry enough soluble sodium salts to limit their value for irrigation reuse.

## FUTURE NEEDS

Substantial development of new irrigated land and better water supplies for much of the land presently irrigated will be required to meet future needs of the region. Projections of the acreage requirements, production from that acreage required, water needs, and the resulting impact on the subregion if these projections can be met are presented in this section.

### Land

The projections of irrigated acreage and production requirements are based on future food and fiber needs. Consideration was given to projected yields, land and water availability, along with economic and social factors affecting irrigation development.

Satisfaction of future food and fiber needs will require an increase in the irrigated area from 480,000 acres in 1966 to 860,000 acres by 1980, 950,000 by year 2000, and 1,320,000 acres by 2020. Total irrigated area needs are presented in table 26. These acreages consist of irrigated cropland harvested and pasture adjusted to include other irrigated lands not used in the production of crops and pasture. Productive irrigated lands consisting of irrigated cropland harvested and pasture are identified by crop categories in table 27.

Table 26 - Irrigated Area Needs by 1980, 2000, and 2020
Subregion 1

| Item | Irrigated Acreage | | |
|---|---|---|---|
| | 1980 | 2000 | 2020 |
| | | (1,000's) | |
| Harvested Cropland and Pasture 1/ | 731 | 808 | 1,122 |
| Other 2/ | 129 | 142 | 198 |
| Total Irrigated Area | 860 | 950 | 1,320 |

1/ From table 27.
2/ Includes irrigated forest, range, rights-of-way, ditches, roadways, farmsteads, urban, and idle irrigated lands not used in the production of projected crop requirements.

Livestock feed crops are expected to continue as the major users of irrigated land in the subregion. Even though there were 4,500 acres of sugar beets grown in 1964, no production is projected for the future since the local processing has recently been discontinued.

Table 27 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020 Subregion 1

| Crop Category | Acreage Needs 1980 | 2000 (1,000's) | 2020 |
|---|---|---|---|
| Small grains | 199 | 163 | 180 |
| All hay | 312 | 382 | 561 |
| Dry beans and peas | -- | -- | -- |
| Sugar beets | -- | -- | -- |
| Potatoes | 5 | 6 | 8 |
| Vegetables | -- | -- | -- |
| Fruits, nuts, and berries | 1 | 1 | 1 |
| Forage seed, hops, and mint | 6 | 6 | 8 |
| Pasture | 176 | 214 | 314 |
| Unenumerated | 32 | 36 | 50 |
| Total | 731 | 808 | 1,122 |

## Production and Yield

Crop production needs from irrigated land are presented for selected crop categories in table 28. This is followed by crop yields in index form using 1964 as the base year in figure 10.

Table 28 - Crop Production from Projected Irrigated Acreage for 1980, 2000, and 2020, Subregion 1

| Crop Category | Units | Production 1980 | 2000 (1,000's) | 2020 |
|---|---|---|---|---|
| Small grain | tons | 325 | 340 | 456 |
| Hay | tons | 807 | 1,175 | 2,105 |
| Potatoes | cwt. | 1,196 | 1,729 | 2,605 |
| Fruits, nuts, and berries | tons | 3 | 5 | 7 |
| Forage seed, hops, and mint | lbs. | 1,162 | 1,471 | 2,505 |

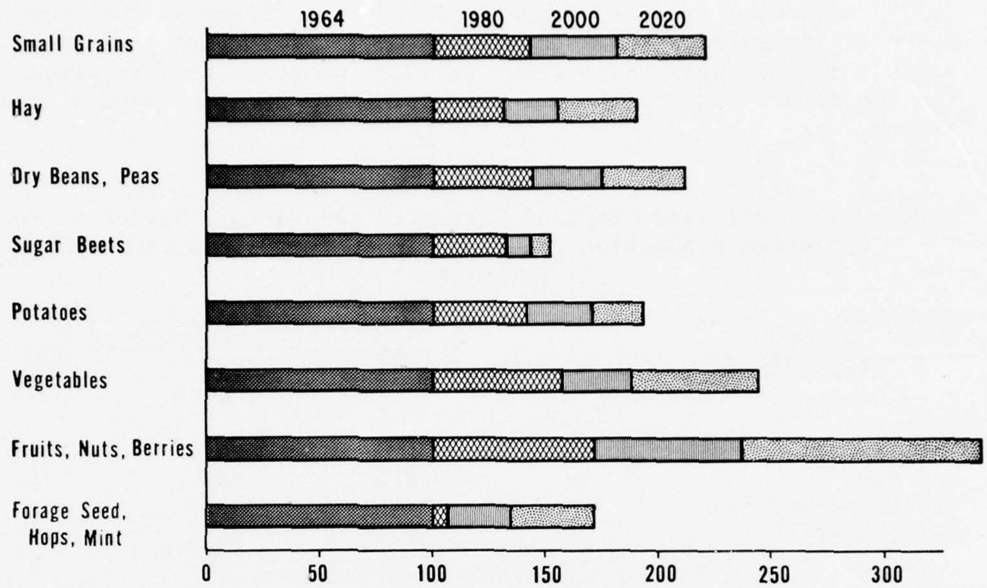



FIGURE 10. Projected Crop Yields in 1980, 2000, and 2020 for Selected Crops (1964 as Base Year Equals 100) Subregion 1.

## Value of Production

Values of projected irrigated crop production are presented in table 29. These values include feed crops consumed by livestock with the exception of pasture production. These values are based on projected normalized prices discussed in the Economic Base Appendix VI.

Table 29 - Value of Projected Irrigated Crop Production
Subregion 1

| Crop Category | Value of Production 1/ 1980 | 2000 ($1,000) | 2020 |
|---|---|---|---|
| Small grains | 17,200 | 18,000 | 24,100 |
| Hay | 17,400 | 25,300 | 45,300 |
| Potatoes | 1,600 | 2,300 | 3,500 |
| Fruits, nuts, and berries | 400 | 600 | 800 |
| Forage seed, hops, and mint | 200 | 300 | 500 |
| Total | 36,800 | 46,500 | 74,200 |

1/ Based on projected normalized prices.

## Water

An additional 2.1 million acre-feet of water will be needed at the farms in Subregion 1 to meet supplemental and full supply requirements of lands expected to be irrigated by 2020. Depletions resulting from the new water supply will total about 1.6 million acre-feet. Estimated farm deliveries and depletions are shown by time periods in table 30.

Table 30 - Projected Farm Deliveries and Depletions
Subregion 1

| | Presently Irrigated | | Future Irrigation | | Total | |
|---|---|---|---|---|---|---|
| Year | Farm Delivery | Depletion | Farm Delivery | Depletion | Farm Delivery | Depletion |
| | | | (1,000 Acre-Feet) | | | |
| 1966 | 1,200 | 730 | | | 1,200 | 730 |
| 1980 | 1,200 | 730 | 870 | 650 | 2,070 | 1,380 |
| 2000 | 1,200 | 740 | 1,080 | 800 | 2,280 | 1,540 |
| 2020 | 1,200 | 750 | 2,100 | 1,540 | 3,300 | 2,290 |

### Supplemental

Some 195,000 acres do not have an adequate water supply at the present time. However, 114,000 acres in the Flathead subarea are expected to continue being irrigated to produce hay and grain for a livestock-based economy with their present inadequate supply. No supplemental water is expected to be needed for these lands.

Supplemental diversion requirements, amounting to 106,000 acre-feet annually, are shown by subarea in table 31. Present farm efficiencies are quite low in this subregion, but it is expected that they will increase enough that the total farm deliveries will not change for the presently irrigated lands. The increased efficiencies will result in an increase in crop use and an additional depletion of about 20,000 acre-feet by 2020 as shown in table 30.

Table 31 - Supplemental Irrigation Diversion Requirements
Subregion 1

| Subarea | Water-Short Lands (acres) | Supplemental Requirement (acre-feet) |
|---|---|---|
| Bitterroot | 43,000 | 50,000 |
| Upper Clark Fork | 18,000 | 40,000 |
| Lower Clark Fork | 4,000 | 2,000 |
| Flathead | 127,000 | 11,000 |
| Kootenai | 1,000 | -- |
| Pend Oreille | -- | -- |
| Upper Spokane | -- | -- |
| Lower Spokane | 2,000 | 2,000 |
| Total | 195,000 | 106,000 |

Full

An estimated additional 2,100,000 acre-feet of water will be needed at the farm to meet irrigation needs by 2020. The total amount of water depleted by this new irrigation is estimated to be 1,540,000 acre-feet. Estimated farm deliveries and depletions for new irrigation development are shown in table 32. In the Montana portion of the subregion these quantities are the same because of the similarity of the drainage basins in which the potential irrigable lands are found. The drainage basins consist of long, relatively narrow valleys between high mountain ranges. Irrigation water use is presently much higher on most of the presently irrigated area in Montana. In the future the majority of irrigation development will probably be by organized projects and sometimes by pumping to higher elevation lands. Such pumping in particular would require more efficient distribution systems and able management.

The irrigation requirements in the Pend Oreille and Upper Spokane subareas reflect the amount of water needed in the northern panhandle of Idaho. The higher requirement in the Upper Spokane subarea is based on more diversified cropping than in the Pend Oreille subarea where it is expected that forage and hay will continue to be the major crops.

The Lower Spokane subarea has the highest requirement in the subregion because of all subareas, its lands are the lowest in elevation, precipitation is lowest, and temperatures and consumptive use are the highest.

Table 32 - Irrigation Requirements and Use
Subregion 1

| Subarea | Present - 2000 Farm Delivery | Present - 2000 Depletion | 2000 - 2020 Farm Delivery | 2000 - 2020 Depletion |
|---|---|---|---|---|
| | (Acre-Feet Per Acre) | | | |
| Bitterroot | 2.1 | 1.6 | 2.6 | 1.9 |
| Clark Fork | 2.1 | 1.6 | 2.6 | 1.9 |
| Flathead | 2.1 | 1.6 | 2.6 | 1.9 |
| Kootenai | 2.1 | 1.6 | 2.6 | 1.9 |
| Pend Oreille | 1.7 | 1.3 | 2.0 | 1.5 |
| Upper Spokane | 2.1 | 1.7 | 2.8 | 2.1 |
| Lower Spokane | 2.8 | 2.2 | 3.4 | 2.5 |

## THE POTENTIAL TO MEET THE NEEDS

There are about 2.5 million acres of potentially irrigable land in Subregion 1. On an average, about 26 million acre-feet of runoff originates in the subregion annually and there is an additional 9 million acre-feet of inflow annually from Canada. To meet projected long-range needs, 840,000 acres of new irrigation development will be required. In addition, 195,000 irrigated acres experience water shortages which must be alleviated if the subregion's share of the region's food and fiber need is to be met.

### Potentially Irrigable Lands

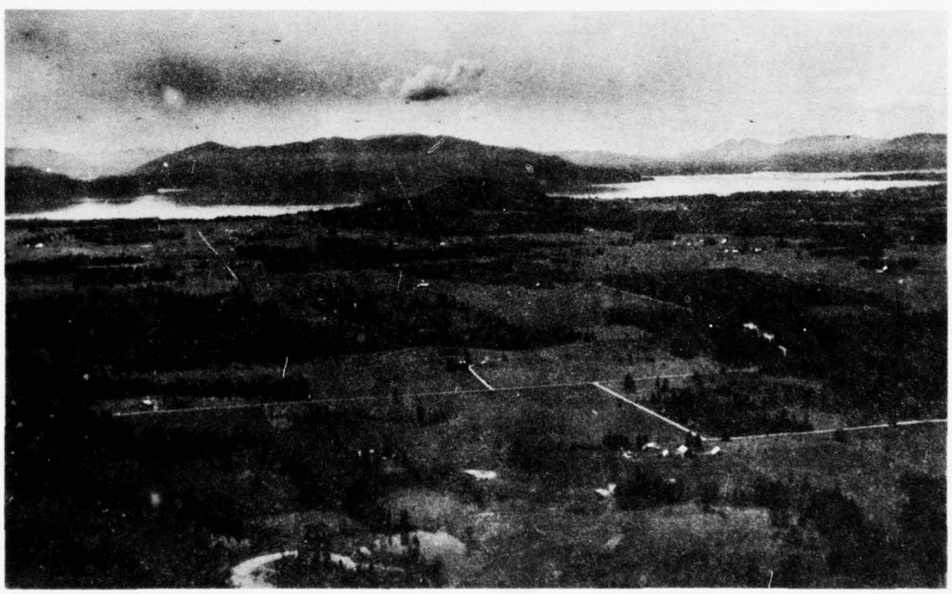
About three-fourths of the potentially irrigable lands are cleared. The 1964 Census of Agriculture indicated about 1,750,000 acres were either lands planted to crops or were being used as pasture. Much of the remaining land with an irrigation potential is covered with timber. Most timbered lands are in state and national forests.

The potentially irrigable agricultural lands are primarily located in the lowland areas; some sizable acreages do occur in certain foothill fringe areas. Scattered, isolated bottom lands, terraces, and benchlands located in the narrow valleys also have some potential. There are wide differences in soils because of the varied climatic, vegetative, topographic, drainage, and geologic conditions occurring throughout the subregion.

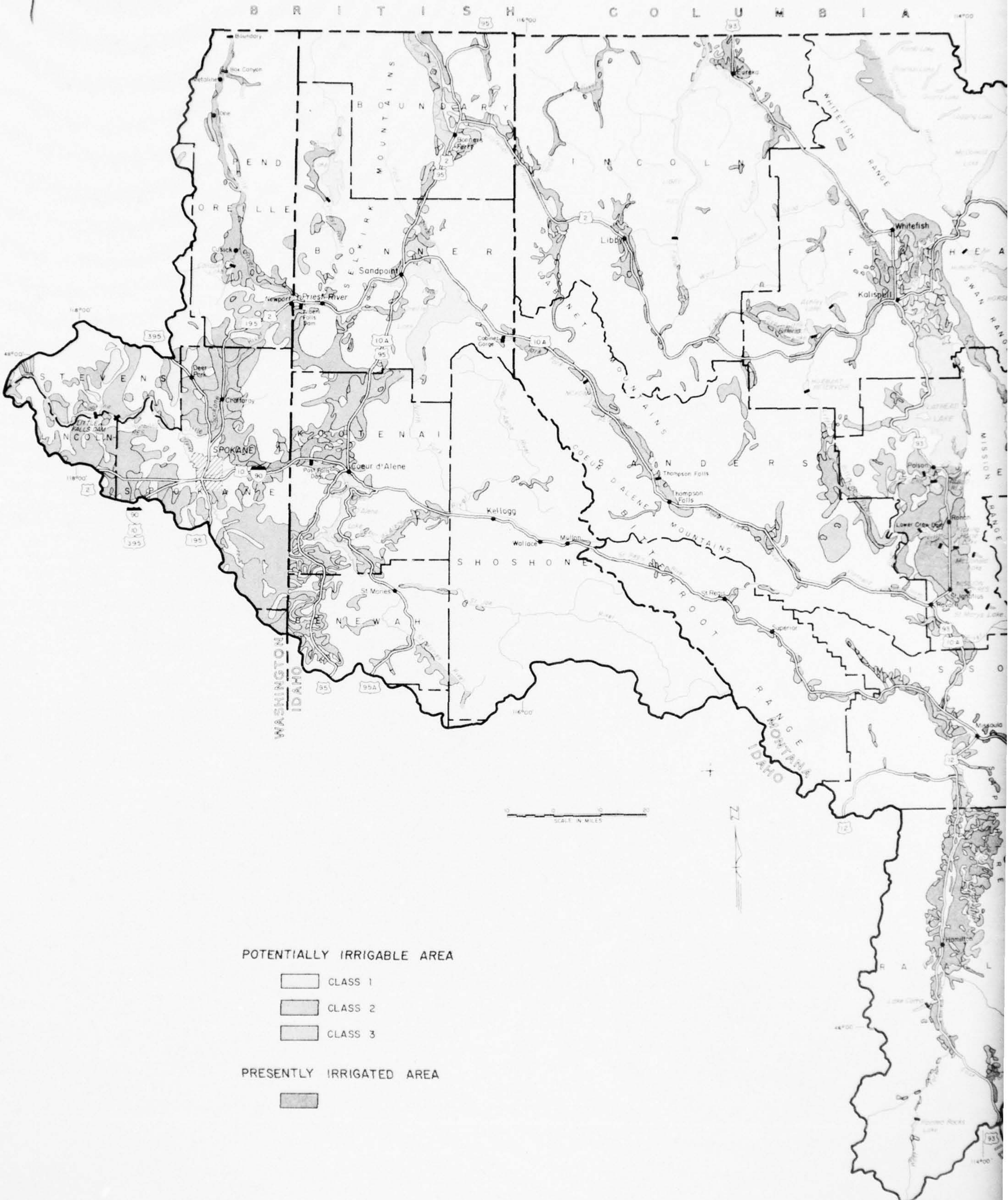
These lands have been identified by three land classes according to subareas and also by states in table 33. Figure 11 shows their location.

Table 33 - Potentially Irrigable Land by States
Subregion 1

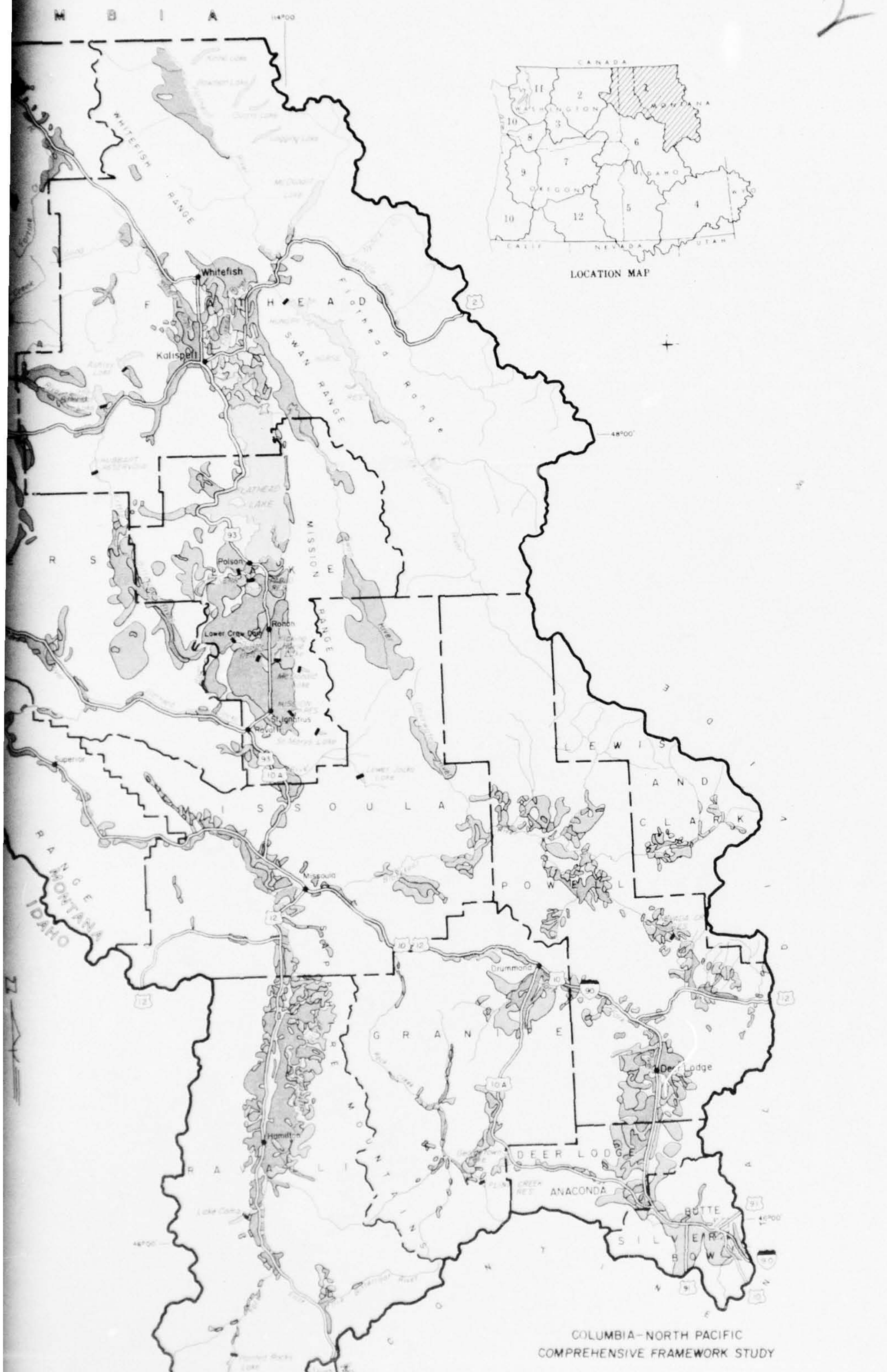
| State | Class 1 | Class 2 | Class 3 | Total |
|---|---|---|---|---|
| | | (Acres) | | |
| Idaho | 40,400 | 206,100 | 270,000 | 516,500 |
| Montana | 29,700 | 157,500 | 1,050,300 | 1,237,500 |
| Washington | 40,800 | 282,200 | 433,400 | 756,400 |
| Total | 110,900 | 645,800 | 1,753,700 | 2,510,400 |
| Percent of Total | 4 | 26 | 70 | 100 |
| Subarea | | | | |
| Bitterroot | 0 | 12,290 | 55,000 | 67,290 |
| Upper Clark Fork | 2,010 | 60,120 | 233,690 | 295,820 |
| Lower Clark Fork | 0 | 6,510 | 164,740 | 171,250 |
| Flathead | 22,940 | 52,550 | 382,300 | 457,790 |
| Kootenai | 9,760 | 72,970 | 153,330 | 236,060 |
| Pend Oreille | 13,920 | 98,270 | 254,540 | 366,730 |
| Upper Spokane | 21,390 | 93,150 | 313,920 | 428,460 |
| Lower Spokane | 40,840 | 250,000 | 196,130 | 486,970 |



*Potentially irrigable lands north of Pend Oreille Lake. (Bureau of Reclamation)*



BRITISH COLUMBIA
BOUNDARY
PEND OREILLE
BONNER
LINCOLN
STEVENS
SPOKANE
KOOTENAI
SHOSHONE
BENEWAH
SANDERS
MISSOULA
Whitefish
Kalispell
Libby
Eureka
Sandpoint
Newport
Priest River
Deer Park
Chattaroy
Spokane
Coeur d'Alene
Kellogg
Wallace
Mullan
St Maries
Thompson Falls
St Regis
Superior
Missoula
Hamilton
Polson
WASHINGTON
IDAHO
MONTANA
SCALE IN MILES
POTENTIALLY IRRIGABLE AREA
CLASS 1
CLASS 2
CLASS 3
PRESENTLY IRRIGATED AREA




COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# POTENTIALLY IRRIGABLE AREA

CLARK FORK, KOOTENAI, SPOKANE, SUBREGION 1

1968

FIGURE 11

A brief description of the characteristics of each class follows.

## Class 1

Class 1 lands total some 110,900 acres or 4 percent of the potentially irrigable lands. About 25 percent are located in Montana and the remaining 75 percent are almost equally divided between Idaho and Washington.

With proper irrigation practices these lands are capable of producing favorable yields of all crops climatically adapted to the various subareas. They are nearly level to gently sloping and are well suited to sprinkler application and to gravity application with a minimum of land preparation.

Water-holding capacities are optimum due to the favorable soil depths and soil textures of these lands. Throughout the subregion, class 1 lands have soils that are at least 40 inches deep and are mostly free of gravel and cobbles. Of special note is the Palouse Hills where class 1 lands may have soils 40 to 50 feet deep. More than 95 percent of the subregion's soils range in texture from silt loams to sandy loams while less than 5 percent have fine textures, such as clay loams, or coarser textures, such as loamy sands. Drainability, both surface and internal, is good and seepage or salt problems are not expected to develop under irrigation. Depth to impermeable barriers is at least 8 feet on class 1 lands.

## Class 2

Class 2 lands total about 645,800 acres and represent some 26 percent of the potentially irrigable lands. Of this amount, 282,200 acres are in Washington, 206,100 acres in Idaho, and 157,500 acres in Montana.

These are good quality lands having only slight deficiencies in soils, topography, or drainability. Any single one or a combination of these deficiencies will limit crop productivity and/or raise production costs when compared to class 1 lands. In Washington, limitations to irrigation would generally be topography and soil depth. The major limitations to irrigating these lands in Idaho would be topography, high water tables, and reduced water-holding capacities. In Montana the major limitations are topography and reduced water-holding capacities of the soils due to gravel and cobbles in the root zone. Throughout the subregion, water tables in class 2 lands will remain below the root zone most of the time during the growing season. Impermeable barriers are generally found at least 6 feet below the surface.

AD-A036 554 PACIFIC NORTHWEST RIVER BASINS COMMISSION VANCOUVER WASH F/G 8/6
COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
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Throughout the subregion soil surface textures of class 2 lands range from silt loams to sandy loams. Deficiencies of these lands include water-holding capacities being significantly reduced due to shallower soils of from 20 to 40 inches in depth; the increased occurrence of gravel, cobbles, or sand in the soil profile; or slope gradients of from 4 to 12 percent.

Irrigation by gravity means could be practiced where topography is suitable. Sprinkler application would be the most practical on lands having rolling topography.

Class 3

Class 3 lands total about 1,753,700 acres or 70 percent of the potentially irrigable lands. There are 1,050,300 acres in the Montana portion of the subregion, 433,400 acres in Washington, and 270,000 acres in Idaho.

Many class 3 lands have shallow soils of from 10 to 20 inches in depth and have one or more of the deficiencies common to class 2 lands, but to a greater degree. In some instances these deficiencies may be severe enough to seriously affect crop capability or production costs. In the Montana portion of this subregion shallow, gravelly, and cobbly soils having greatly reduced water-holding capacities necessitate more frequent applications of irrigation water. Slope gradients in Washington, as well as elsewhere in the subregion, ranging up to 20 percent, could affect equipment and operation costs.

In Washington and Idaho depth to impermeable barriers is of particular concern where Columbia River basalts generally occur only about 6 feet below the surface on class 3 lands. These basalts, where they occur at even shallower depths, are potential drainage hazards and could result in harmful salt buildup under irrigation.

Fine textured subsoils are prevalent in class 3 lands throughout the subregion and tend to create drainage problems by retarding water movement.

Where topography is the limiting factor, only sprinkler application would be practical.

## Water Supply

Average annual discharge of streams in the subregion is about 35 million acre-feet, of which 9 million acre-feet enter from Canada and 26 million acre-feet originate within the subregion.

An estimated 69 million acre-feet of water are stored in the uppermost 50 feet of the saturated portion of the ground water aquifer. Gross annual natural discharge from the aquifer is estimated at 24 million acre-feet. The net discharge is about 19 million acre-feet, however, because some water goes through the recharge-discharge cycle more than once before leaving the subregion.

## Potential Developments

In order to meet the long-range irrigation need of the additional 840,000 acres allotted to Subregion 1 by 2020, the resources and initiative of Federal and State agencies, together with private enterprise, will have to be accelerated far beyond present plans. Federal projects are currently under study which could provide only about one-third of this acreage with a full water supply. There are about 2.5 million acres of potentially irrigable lands in the subregion and an adequate water supply to meet its long-range irrigation needs. However, it will be extremely costly to develop means of getting water to many of these lands.

In order for the 1980 needs to be met, there would have to be a 60 percent increase of the presently irrigated acreage. This seems highly unlikely in view of recent trends and anticipated developments although this increase would not be impossible to achieve.

### Development by Subarea

Bitterroot There are slightly more than 67,000 acres of potentially irrigable land in this subarea; however, about 43,000 acres of the 109,000 acres irrigated in the valley are presently receiving an inadequate water supply. It is estimated that an additional 20,000 acres of new irrigation development and the presently irrigated water-short lands could be provided an adequate water supply. The potentially irrigable lands in this subarea are made up entirely of class 2 and class 3 lands.

Upper Clark Fork There are about 295,000 acres of potentially irrigable land, most of which is class 3, in this subarea. These lands are generally in small scattered tracts except for a block of about 150,000 acres between Garrison and Butte. This is a water-short subarea and storage would be required.

Lower Clark Fork The 171,000 acres of potentially irrigable land, which are almost entirely class 3, are located in a narrow band along the Clark Fork River. The water supply for irrigation development of all or a portion of these lands would most likely be provided by pumping from the Clark Fork River.

Flathead Some 458,000 acres have been identified as potentially irrigable in this subarea, and it is estimated that a substantial amount of these lands could be served by pumping from the Flathead River and/or storage on tributary streams. Most of these lands are located in the Kalispell area north of Flathead Lake and in and near the Flathead Indian Reservation to the south of Flathead Lake.

There are about 20,000 acres of potentially irrigable class 3 land located along the lower reaches of the Little Bitterroot River.

Kootenai This subarea is characterized by an abundance of water resources and a total potential of 236,000 acres of irrigable lands. Development could be accomplished by pumping from the Kootenai River and its tributaries. The most likely to be developed irrigable lands are generally located along the bottoms of river valleys.

Pend Oreille There are almost 367,000 acres of potentially irrigable land located along or near the Pend Oreille River and its tributaries. Pumping from Pend Oreille Lake, Pend Oreille River, and tributary streams is the most likely source of water. Water supplies are adequate to serve all present and future development. Most irrigation development would occur at the lower elevations along the streams.

Upper Spokane There are over 428,000 acres of potentially irrigable land upstream from Spokane, Washington. Much of the presently irrigated land receives its water supply from an extensive aquifer in the Spokane Valley and Rathdrum Prairie. Ground water from this aquifer will serve as an important source for potentially irrigable lands lying east of Spokane, Washington, and northwest of Coeur d'Alene, Idaho. Other lands could be served by pumping from the Spokane River or such tributaries as the Coeur d'Alene River or Coeur d'Alene Lake. The pump lifts required are not expected to be excessive.

Lower Spokane There are nearly 487,000 acres of potentially irrigable land in this subarea. Pumping from the Spokane River and tributary streams is a likely source of water. Pump lifts could be as much as 500 to 700 feet. In addition, some water from the Spokane Valley aquifer could possibly be used as a source of water for some lands north and northeast of Spokane. Lands in this area are best suited to sprinkler irrigation with relatively few lands requiring extensive clearing.

## Private Developments

The potentially irrigable lands in the Montana portion of the subregion are generally in small scattered tracts. Development

of most of these lands can best be accomplished by private groups and individuals. It is anticipated that all new land development will be sprinkler-irrigated with only existing gravity systems being extended to develop small acreages.

Private enterprise is expected to continue developing some acreage by pumping from the extensive aquifer located in the Rathdrum Prairie area. Surface flows from the Spokane River will be partially developed using high pump lifts.

## State Developments

The States of Idaho, Washington, and Montana are actively participating with Federal agencies in the development of water and land resources. In addition, these states are developing statewide plans which will include potential irrigation developments.

## Federal Developments

Feasibility studies of potential multiple-purpose project developments in the three states in this subregion have identified plans to irrigate some 340,000 acres. In addition, studies directed to developing smaller projects located in the upper river reaches and their tributaries include over 160,000 acres that are potentially irrigable.

While it is recognized that there is some duplication of acreages being evaluated by Federal, State, and private interests, no effort has been made in this study to delineate and assign definite acreage development to the three entities.

The developments being studied in each of these states are all based primarily on pumping water from the Flathead and Spokane Rivers and from the Rathdrum Prairie aquifer. Water supplies will also be used from existing small reservoirs on tributary streams and lakes located throughout the subregion.


LOCATION MAP

SUBREGION 2

# SUBREGION 2

# UPPER COLUMBIA

## THE SETTING

Subregion 2 lies entirely within the State of Washington. Located in the north-central part of the state, its boundaries are, on the east, south, and west, a line connecting the tributary drainages of the Columbia River upstream from the Snake River, excluding the Yakima and Spokane Rivers, and on the north the International Boundary. The subregion contains 22,451 square miles (14,368,900 acres) and represents 8 percent of the region's area.

As shown in figure 12, Subregion 2 has been divided into three subareas for discussion purposes. The Chelan-Okanogan subarea, in the northwest portion of the subregion, contains all of Chelan and Okanogan Counties. The Ferry-Stevens subarea, in the northeast portion, contains all of Ferry County and those portions of Stevens and Pend Oreille Counties within the subregion's Columbia River drainage. The remainder of the subregion is called the Big Bend subarea. It derives its name from the big bend of the Columbia River which forms its northern and western boundaries. This subarea contains all of Douglas and Grant Counties, nearly all of Lincoln, Adams, and Franklin Counties and a portion of Kittitas and Spokane Counties.

Annual precipitation ranges from 5 to 20 inches throughout the lowlands where the major agricultural districts are located. The higher valleys and the mountainous portion of the Ferry-Stevens subarea and the eastern one-third of the Chelan-Okanogan subarea receive from 20 to 40 inches annually. The western part of the Chelan-Okanogan subarea is located along the east slope of the Cascade Mountains, and its higher valleys and mountainous portion receive from 20 to 150 inches of precipitation per year.

Elevation is the key to the subregion's range in temperature and frost-free period. The mean annual temperature ranges from 45° F. to 55° F. Monthly mean ranges for January are from about 20° F. to 32° F. and for July from 65° F. to 75° F. The frost-free period ranges from 100 to 200 days in the agricultural areas. The southwest portion of the Big Bend subarea has the longest crop-growing period due to steady southwesterly winds restricting the formation of frost pockets. Upland and mountainous areas have shorter frost-free periods that generally range from 80 to 100 days.

Natural vegetation patterns are influenced by both elevation and precipitation. Extensive stands of ponderosa pine and Douglas

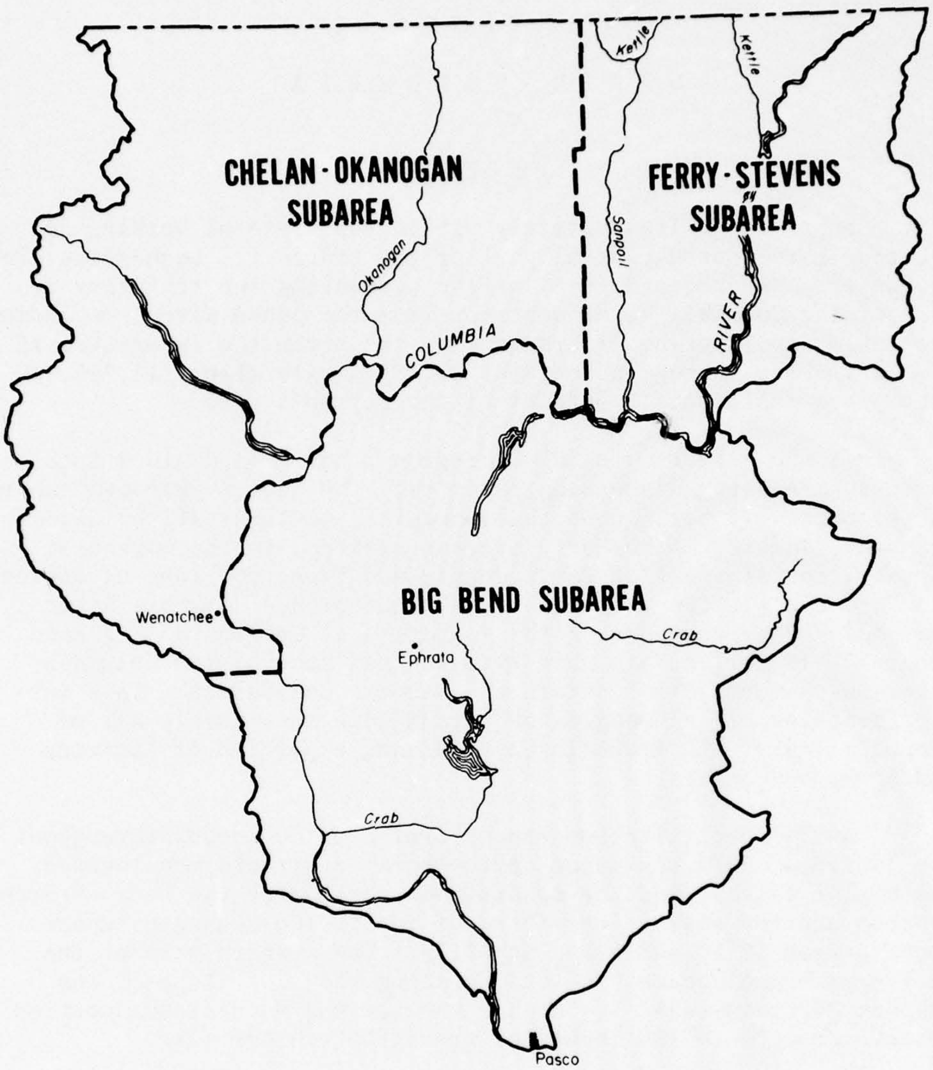



FIGURE 12. Subareas in Subregion 2, Upper Columbia

fir are located in the more mountainous portions of the subregion. Where still remaining, the natural vegetation in the lower areas is characterized by open grasslands and scattered trees, forbs, and shrubs. Much of these latter areas are being developed for agriculture.

Sizable streams such as the Wenatchee, Okanogan, Kettle, Chelan, and Methow Rivers enter the Columbia River from the Chelan-Okanogan and Ferry-Stevens subareas; the tributaries, especially the Wenatchee and Chelan, drain extensive snowfields in the Cascade Mountains and have comparatively large and sustained runoff. Surface runoff from the Big Bend subarea is quite small and generally from intermittent streams.

The topography of the subregion is diverse and is a controlling factor on the location of agricultural lands. The most extensive agricultural areas are located in the Big Bend subarea. The Chelan-Okanogan and Ferry-Stevens subareas have more rugged topography, and agricultural areas are limited to the lower valley lands.

Settlement began in the mid-1800's following a period of early trading development at Fork Okanogan and Fort Colville. Settlement was stimulated by a series of Federal Acts and grants, most notably the Homestead Act of 1862, that made public domain lands available for development. Lands were also made available through sales by railroad developers and by the sale and leasing of State lands after statehood in 1889.

Important to the growth and development of the subregion was the advent of the railroads in the late 1800's. Presently an excellent network of both railroads and local, State, and Federal roads serve the subregion. Commercial air service and Columbia River port facilities at Pasco also serve the subregion. Air service is also available at Wenatchee and Ephrata.

Agriculture, forestry, and manufacturing are the principal employers in the subregion. Wenatchee, Pasco, and Moses Lake are important as processing, trade, and service centers. Population in 1965 totaled 198,600 or about 3.6 percent of the total for the region.

Irrigation development occurred first in the Chelan-Okanogan subarea in the 1850's. Probably the first irrigated orchard in Washington was developed near Osoyoos Lake in Okanogan County, where in 1858 a ditch was constructed to divert water from Nine Mile Creek to irrigate a planting of 1,200 apple trees.

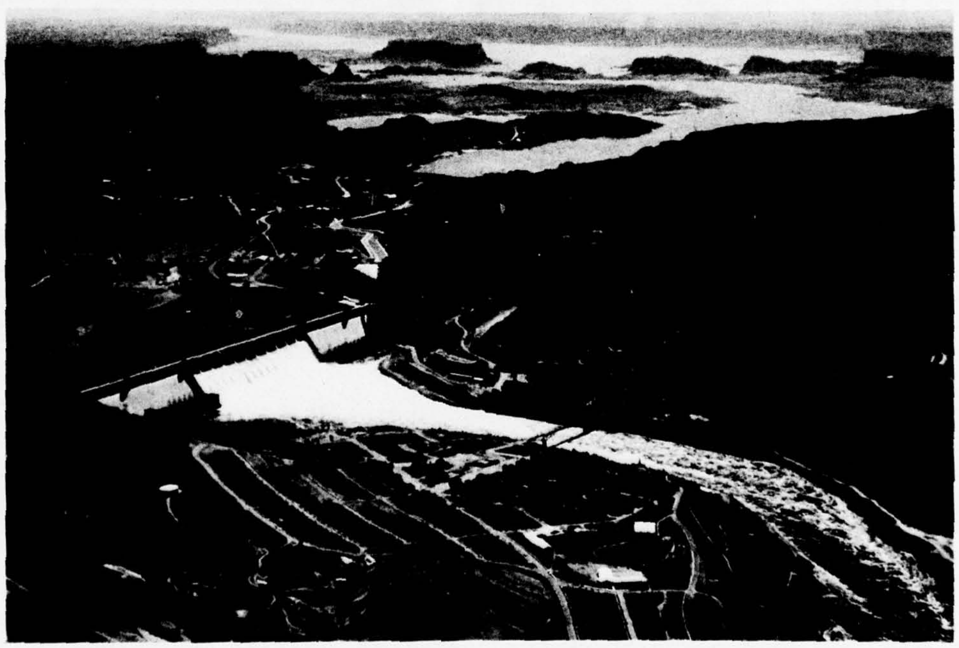
Early farming ventures in the Chelan-Okanogan subarea were successful due to irrigation, and the area gained a reputation for high quality fruit production. In contrast, however, were attempts to farm the Big Bend subarea in early years; these attempts often ended in disaster due to a succession of serious droughts.

The advent of railroads in the late 1800's expanded the market potential of the subregion's farms and further stimulated irrigation development in the Chelan-Okanogan subarea. By the early 1900's,

farmers had appropriated most of the water of the smaller streams; and those systems that could be constructed by private capital had been built. The largest system--the High Line--was completed in the Wenatchee Valley in 1903. At that time each subarea had a principal form of agricultural activity; irrigated fruit production centered in the Chelan-Okanogan subarea; large dryfarms devoted to grain production characterized the Big Bend subarea; and livestock forage production predominated in the Ferry-Stevens subarea.

In 1902, the Reclamation Service started preliminary investigations of the Okanogan Project near the towns of Omak and Okanogan. Completion of its construction in 1921 permitted the irrigation of 10,000 acres.

In 1903, the Reclamation Service began investigations to determine the feasibility of delivering irrigation water to a large section of the Big Bend subarea. Investigations were made over a number of years of several water delivery plans, including the gravity diversion of northern Idaho water and the construction of a high dam at the head of Grand Coulee to allow the pump lifting of Columbia River waters onto the dry lands. In 1934, after many years of study and promotion by local interest groups, Congress appropriated money for construction of Grand Coulee Dam--the beginning of the largest reclamation project in the Northwest. Irrigation water was first supplied to an area near Pasco in 1948. By 1966 nearly a half million acres of dry land had been brought under irrigation.



*Grand Coulee Dam--giant contributor to irrigation development in Subregion 2. (Bureau of Reclamation)*

Also important to the development of irrigation in this subregion was the 1952 enactment of Public Law 577 which provided for the Secretary of the Interior to study arid lands in the vicinity of the Chief Joseph Dam Project on the Columbia River and to seek authorization for construction of irrigation works in connection with Chief Joseph Dam. Since enactment of Public Law 577, two divisions have been authorized and constructed to serve nearly 10,000 acres. Lands in this project are located generally along the Columbia and Okanogan Rivers.

The tremendous hydroelectric development that has taken place on the Columbia River has had an impact on irrigation development by providing the basis for favorable pumping and power rates and financial assistance from Federal power revenues in meeting reimbursable irrigation costs on Federal reclamation projects.

Recently lands in Adams, Lincoln, and Grant Counties have been developed for irrigation using water from deep wells. This practice has grown steadily in the last several years and is now at the point where demand for water exceeds available supplies.

## PRESENT STATUS

This subregion contains more irrigated acreage than any other in the state. Production of crops on irrigated land is the largest user of water. In addition to cropland, a small acreage of irrigated land is devoted to forest nurseries and seed orchards, recreation sites, and minor tracts used for wildlife and other purposes. Table 34 lists the acreage in the irrigated area by source and adequacy of supply and by method of irrigation.

Table 34 - Irrigated Area, 1966, Subregion 2

| Source of Supply | | Adequacy of Supply | | Method of Irr. | | |
|---|---|---|---|---|---|---|
| Surface | Ground | Adeq. | Inadeq. (Acres) | Sprinkler | Gravity | Total |
| 671,000 | 58,000 | 692,000 | 37,000 | 320,000 | 409,000 | 729,000 |

### Characteristics of Irrigated Areas

Of the 729,000 total acres irrigated in 1966, 635,000 acres were in the Big Bend subarea, 71,000 acres in the Chelan-Okanogan subarea, and 23,000 acres in the Ferry-Stevens subarea. Figure 13 shows their location.

Agriculture in the Big Bend subarea is characterized by small grain, field, forage, and vegetable crops and livestock production. There is some effort to develop fruit orchards where air drainage is favorable. Irrigation permits production of forage crops in excess of the subregion's needs; much of this excess is shipped to the Puget Sound area for use in the dairy industry.

The Chelan-Okanogan subarea is one of the Nation's important fruit growing areas. Development has taken place in the valleys of the Wenatchee, Entiat, Chelan, Methow, and Okanogan Rivers, and along lower Lake Chelan.

The Ferry-Stevens subarea is dominated by livestock farming with irrigated forage crops supporting beef herds.

The lands being irrigated have soils that range from deep silt loams in the Big Bend subarea to gravelly, cobbly loams in the irrigated valleys in the Chelan-Okanogan and Ferry-Stevens subareas. The topography of the irrigated lands is generally level to gently sloping, although gradients of up to 25 percent are not uncommon on some of the apple-producing lands. The soils are generally well drained and free from harmful salts.

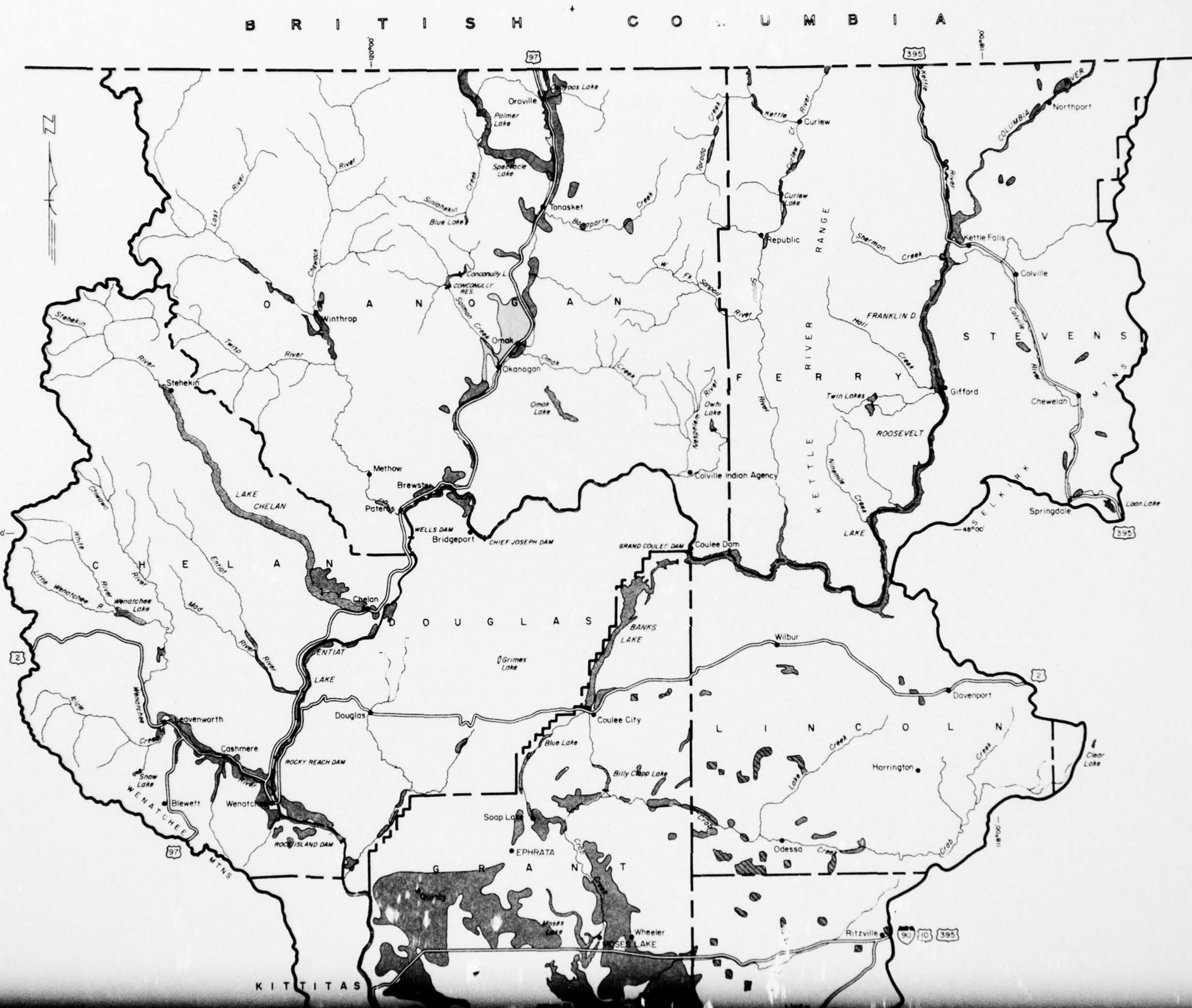
According to the 1964 Census of Agriculture, there were 6,000 farms with irrigated land; this number represents about 62 percent of the more than 9,700 farms in the subregion. The average irrigated farm had about 90 acres under irrigation.

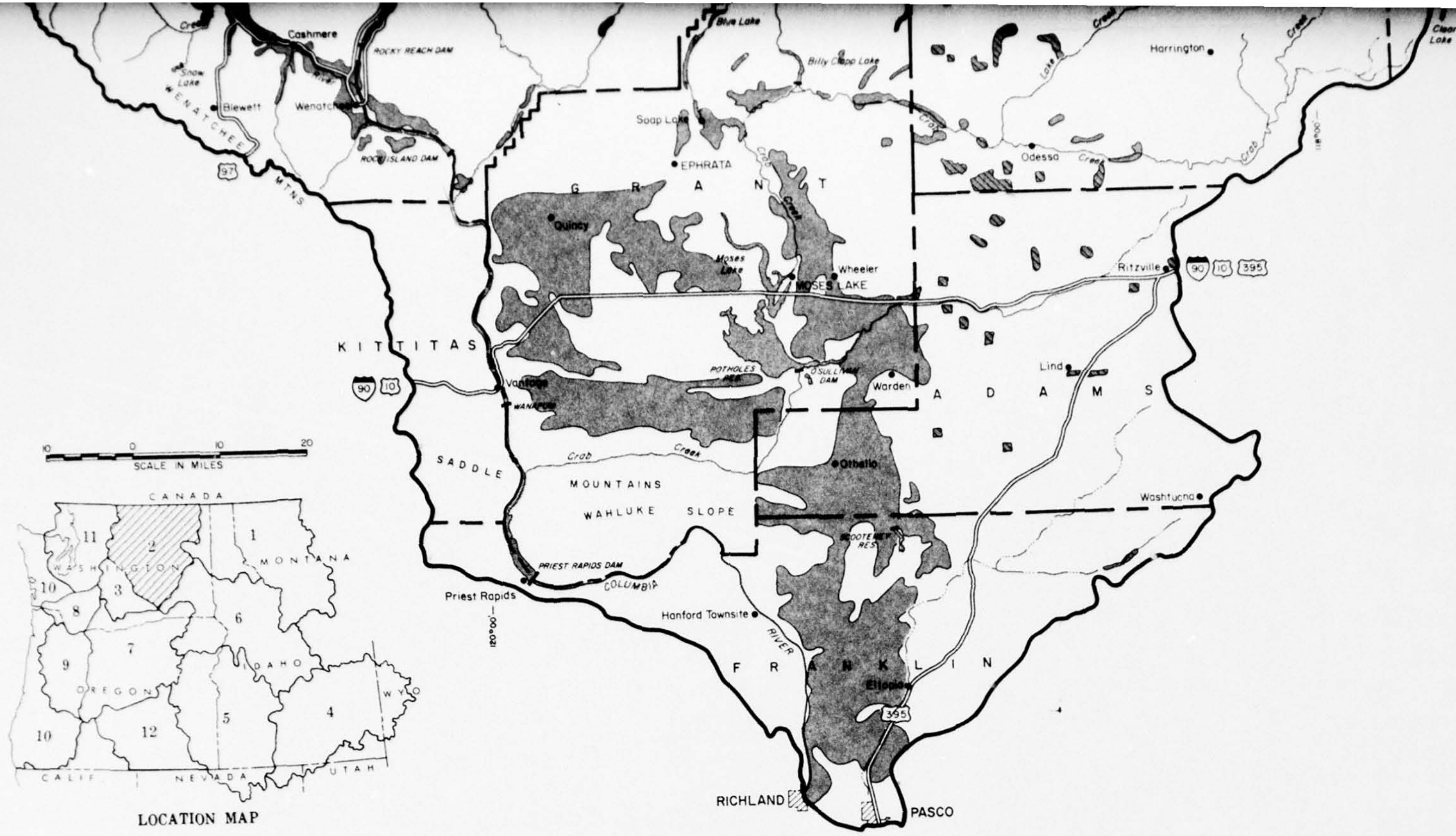
The majority of the acreage devoted to fruit, vegetable, and nongrain field crops is irrigated. Dairy and other livestock farms that produce all or most of their own forage devote a portion of the farm acreage to irrigated pasture and hayland. Poultry and cash-grain field crop farms are the only farm types generally nonirrigated; however, a small number of grain farms have limited irrigated acreages.

## Production of Irrigated Crops

Irrigation development has resulted in the subregion's high ranking in terms of percentage of production for many of the major irrigated crops in the region. For example, in 1964 the following percentages of the region's production of these crops were grown in Subregion 2: Apples (50); apricots (28); wheat (24); dry beans, cherries, and alfalfa hay (18); pears and potatoes (16); sugar beets, peaches, and barley (15); and mint (11).

The subregion also has major importance nationally. In 1964, 10 percent of the Nation's apple crop, 9 percent of the mint, and 7 percent of the sweet cherries were grown in the subregion.


BRITISH COLUMBIA
OKANOGAN
FERRY
STEVENS
CHELAN
DOUGLAS
LINCOLN
GRANT
KITTITAS
Oroville
Osoyoos Lake
Palmer Lake
Spectacle Lake
Tonasket
Bonaparte Creek
Blue Lake
Sinlahekin Creek
Conconully L.
CONCONULLY RES.
Salmon Creek
Omak
Okanogan
Omak Lake
Omak Creek
Winthrop
Twisp River
Chewack River
Lost River
Stehekin
Stehekin River
LAKE CHELAN
Methow
Brewster
Pateros
WELLS DAM
Bridgeport
CHIEF JOSEPH DAM
GRAND COULEE DAM
Coulee Dam
Colville Indian Agency
Nespelem River
Owhi Lake
Toroda Creek
W. Fk. Sanpoil
Sanpoil River
Curlew
Curlew Lake
Kettle River
Republic
KETTLE RIVER RANGE
Sherman Creek
FRANKLIN D. ROOSEVELT LAKE
Hall Creek
Twin Lakes
Ninemile Creek
Gifford
Kettle Falls
Colville
Colville River
Chewelah
Northport
COLUMBIA RIVER
SELKIRK MTNS
Springdale
Loon Lake
Chiwawa
White River
Little Wenatchee R.
Wenatchee Lake
Entiat River
Mad River
ENTIAT LAKE
Chelan
BANKS LAKE
Grimes Lake
Wilbur
Davenport
Coulee City
Blue Lake
Billy Clapp Lake
Douglas
ROCKY REACH DAM
ROCK ISLAND DAM
Leavenworth
Cashmere
Wenatchee
Wenatchee River
Icicle Creek
Snow Lake
Blewett
WENATCHEE MTNS
Soap Lake
EPHRATA
Quincy
Moses Lake
MOSES LAKE
Wheeler
Crab Creek
Lake Creek
Odessa
Harrington
Clear Lake
Ritzville
97
395
2
90
10
120°00'
118°00'
48°00'




ADEQUATE WATER SUPPLY

INADEQUATE WATER SUPPLY

GROUNDWATER SUPPLY

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

IRRIGATED AREA

UPPER COLUMBIA, SUBREGION 2

1968

FIGURE 13

2

*Apples grown on irrigated lands in the subregion have a nationwide reputation for high quality. (Bureau of Reclamation)*

It also is an important cattle area, producing 8 percent of the cattle and calves fed grain or concentrate and 11 percent of all cattle and calves sold in the region in 1964.

The food processing industry, especially for fruits and vegetables, has become increasingly important in the subregion. Thus, the impact of irrigation is also felt throughout the local economy in terms of employment and income that it generates.

About 252,000 acres were used to produce feed for livestock--90 percent in pasture, hay, and silage crops and 10 percent in livestock feed grains according to the 1964 Census of Agriculture. The second largest use of irrigated land was for field crops with 114,000 acres. Vegetables were grown on 8,000 irrigated acres. Although this is one of the largest fruit producing areas in the region, only 10 percent of the irrigated cropland (54,000 acres) was devoted to fruit production. Irrigated wheat was grown on 85,000 acres. Land in soil building crops, fallow, and cropland not harvested accounted for about 14,000 acres. Figure 14 illustrates the relative distribution of irrigated cropland harvested and pasture in 1964.

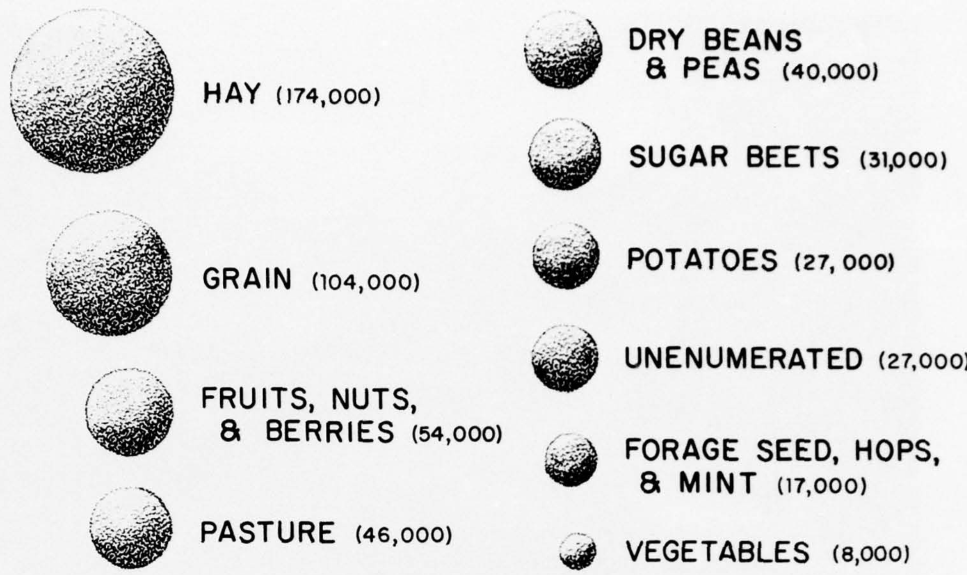



FIGURE 14. Acreage of Irrigated Cropland Harvested and Pasture, Subregion 2, 1964.

Production of irrigated crops is compared to total production by crop category in table 35. Small grains, with about 16 percent, is the only category in which irrigated land does not provide the major portion of total production. About 75 percent of hay production and virtually 100 percent of all remaining crop production comes from irrigated land. Yields of selected major irrigated crops are presented in table 36.

Table 35 - Summary of Crop Production, 1964, Subregion 2

| Crop Category | Units | Production Total (1000's) | Production Irrigated (1000's) | Percent Irrigated |
|---|---|---|---|---|
| Small grains | tons | 1,308 | 206 | 15.7 |
| All hay | tons | 963 | 723 | 75.1 |
| Dry beans and peas | cwt. | 795 | 795 | 100.0 |
| Sugar beets | tons | 708 | 708 | 100.0 |
| Potatoes | cwt. | 8,753 | 8,753 | 100.0 |
| Vegetables | cwt. | 798 | 798 | 100.0 |
| Fruits, nuts, and berries | tons | 405 | 405 | 100.0 |
| Forage seed, hops, and mint | lbs. | 4,706 | 4,693 | 99.7 |

Source: Derived from Census of Agriculture and Agricultural Statistic

Table 36 - Yields for Selected Major Crops in 1964, Subregion 2

| Crop | Unit | Yield per Irrigated Acre |
|---|---|---|
| Grains and Forages | | |
| Corn | bu. | 102 |
| Corn Silage | ton | 21.2 |
| Alfalfa Hay | ton | 4.6 |
| Field Crops | | |
| Potatoes | cwt. | 320.6 |
| Sugar Beets | ton | 23.0 |
| Mint | lb. | 71.0 |
| Alfalfa Seed | lb. | 273 |
| Dry Beans | cwt. | 18.9 |
| Dry Peas | lb. | 2,140 |
| Vegetables | | |
| Sweet Corn | ton | 6.1 |
| Green Peas | ton | 1.8 |
| Dry Onions | cwt. | 472 |
| Carrots | ton | 17.9 |
| Fruits, nuts, and berries 1/ | ton | 7.4 |

1/ Data not available for individual crops.

Production of livestock and livestock products is dependent upon irrigated forage and feed crops. It has been estimated that 48 percent of the total livestock feed requirement is supplied from irrigated land. This estimate excludes feed crops exported from the subregion.

## Value of Production

The total value of sales of crops and livestock products from irrigated land in 1964 has been estimated to be about $128 million. This estimate includes $102 million value placed on irrigated crops excluding livestock feed and about $26 million value for livestock and livestock products.

## Economic and Social Impacts

The gross value of products and services derived from irrigated farms and employment associated with irrigated agriculture in

1964 is shown in table 37. It is estimated that irrigation use has greatly enhanced processing and trades and services industries which added economic values more than double the value of sales of agricultural products as shown in table 37. This enhancement has generated more than one and a half times the man-years of employment

Table 37 - Gross Value of Agricultural Products and Services Associated with Irrigation Use in 1964, Subregion 2

| Industry | Gross Value ($1,000,000) |
|---|---|
| Basic Agriculture | 128 |
| Processing | 104 |
| Trades and Services | 208 |
| Total | 440 |

engaged in basic irrigated agriculture--on farms would generate 9,000 man-years; processing, 2,600; and trades and services, 12,900, or a total of 24,500 man-years.

## Use of Water

There were 729,000 acres irrigated in 1966 of which 92 percent were served from surface diversions. Of the 671,000 acres served from surface sources, more than a half million acres received water from storage. The principal source of water is the Columbia River. Of the Columbia River tributaries in the subregion, the most extensive use is made of the Wenatchee and Okanogan Rivers in the Chelan-Okanogan subarea and Crab Creek in the Big Bend subarea. Other significant tributaries include the Entiat, Chelan, Methow, Kettle, and Colville Rivers.

Over a half million acres are served by pump diversions from the Columbia River. The largest single diversion from the Columbia River is for the Columbia Basin Project. In 1966 this diversion amounted to 2,220,000 acre-feet.

The key feature of the Columbia Basin Project is Grand Coulee Dam. Irrigation water is lifted from Franklin D. Roosevelt Lake by six giant pumps to Banks Lake. From Banks Lake, the water is transported to the farms by a canal and lateral system which extends from north of Ephrata to Pasco at the southern edge of the subregion--a distance of 160 miles from Grand Coulee Dam.

In addition, several other pump diversions are made from the Columbia River near the towns of Bridgeport, Brewster, and Wenatchee. These diversions serve units of the Federally constructed Chief Joseph Dam Project.

Diversions from subregion streams and ground water sources were estimated to total 3,230,000 acre-feet for the 1966 level of development. Return flows amounted to 540,000 acre-feet, resulting in depletions of 2,690,000 acre-feet.

Surface water diversions total over 3 million acre-feet as shown in table 38. These include the large diversion to the Columbia Basin Project in the Big Bend subarea and 10,000 acre-feet for 3,000 acres in Subregion 6 near the Snake River. The diversions in the Big Bend subarea reflect reuse of about 1 million acre-feet of return flow.

Potholes Reservoir, which is located near the center of the Columbia Basin Project, collects drainage water and operational waste from the higher elevation lands in the northern portion and stores them for use on the southern portion. Roughly one-third of the project's half million acres are served from return flow.

Table 38 - Irrigation from Surface Water Sources
1966 Level, Subregion 2

| Subarea | Adequate Supply Area (acres) | Adequate Supply Diversion (ac-ft) | Inadequate Supply Area (acres) | Inadequate Supply Diversion (ac-ft) | Return Flow (ac-ft) | Depletion (ac-ft) |
|---|---|---|---|---|---|---|
| Ferry-Stevens | 20,000 | 80,000 | 1,000 | 3,000 | 38,000 | 45,000 |
| Chelan-Okanogan | 62,000 | 289,000 | 5,000 | 21,000 | 145,000 | 165,000 |
| Big Bend | 583,000 | 2,657,000 | -- | -- | 297,000 | 2,360,000 |
| Total | 665,000 | 3,036,000 1/ | 6,000 | 24,000 | 480,000 | 2,580,000 1/ |

1/ Includes 10,000 acre-feet diverted to 3,000 acres in Subregion 6.
Source: Soil Conservation Service and Bureau of Reclamation data.

Much of the surface water diverted since project development began has found its way into the ground water aquifers. Deep percolation from irrigation has raised the water table substantially in some areas of the project, and drainage problems have resulted. Relatively little return flow now finds its way back to the Columbia River. An estimated 800,000 acre-feet of return flow was going into ground water storage in 1966 and is not included in the total shown in table 38. When the water table becomes stabilized, the return flow to the Columbia River from the Columbia Basin Project should increase.

Irrigation return flow is estimated to be 480,000 acre-feet annually from surface diversions. Although the diverted amount in the Big Bend subarea is large, return flows to the Columbia River are relatively small because of the use of return flows on lower lands and because deep percolation losses are building up the ground water table.

Irrigation depletions total about 2.6 million acre-feet annually from rivers and streams. Since return flows from the Columbia Basin Project are not large, much of the water presently diverted in the Big Bend subarea results in depletion, mostly of Columbia River water.

Table 39 presents the diversions from ground water by subarea. Withdrawals from ground water total about 170,000 acre-feet to serve 58,000 acres. Ground water use accounts for only 5 percent of the total water diversion. Almost 90 percent of the acreage served by ground water pumping is located in the Big Bend subarea. All ground water development has been by private means.

Table 39 - Irrigation from Ground-Water Sources
1966 Level, Subregion 2

| Subarea | Adequate Supply Area (Acres) | Adequate Supply Diversion (ac-ft) | Inadequate Supply Area (Acres) | Inadequate Supply Diversion (ac-ft) | Return Flow (ac-ft) | Depletion (ac-ft) |
|---|---|---|---|---|---|---|
| Ferry-Stevens | 2,000 | 7,000 | -- | -- | 3,000 | 4,000 |
| Chelan-Okanogan | 4,000 | 17,000 | -- | -- | 8,000 | 9,000 |
| Big Bend | 21,000 | 86,000 | 31,000 | 60,000 | 49,000 | 97,000 |
| Total | 27,000 | 110,000 | 31,000 | 60,000 | 60,000 | 110,000 |

Source: Soil Conservation Service and Bureau of Reclamation data.

Throughout much of the subregion, ground water development has taken place in the valley bottoms and on the terraces along principal streams, where water is found in unconsolidated materials such as sand and gravel deposits. However, the most intensively used aquifers of the Big Bend subarea are found in basalt formations. Adequate quantities of water for irrigation and other uses are being obtained from wells drilled into or through the zone of contact between one basalt flow and another. Most of these irrigation wells range in depth from 200 to 700 feet and seasonal yields of 500 acre-feet from individual wells are common. As a result of intensive localized development, ground-water levels are declining in a large area near Odessa.

Return flow from ground water use is estimated to be approximately 60,000 acre-feet annually, most of which is in the Big Bend subarea.

Ground water depletion is estimated to be about 110,000 acre-feet per year. This occurs mainly in Adams, Lincoln, and Grant Counties in the Big Bend subarea.

## Adequacy of Supply

Water supplies are generally adequate for lands receiving their water supply from the Columbia River and most of its tributaries. The 37,000 acres with inadequate supplies are located on figure 13. About 6,000 acres of land with surface supplies are in need of additional water. Irrigators dependent on natural runoff can experience serious shortages during years of low runoff, especially along small tributary streams. There are 4,600 acres in the Okanogan Project near the towns of Omak and Okanogan that experience shortages averaging 2,000 acre-feet; these shortages could average 8,000 acre-feet during a repetition of the 10-year critically dry period of record. This is the largest single block of water-short land in the subregion.

In recent years heavy ground water pumping in Adams, Lincoln, and Grant Counties has resulted in a lowering of the water table. Present users are obtaining adequate irrigation supplies from these wells, although many wells have had to be drilled deeper. The lowering of the water table has interfered with previously established domestic and municipal wells. However, the annual decline should decrease if no new wells are drilled and the water table should reach equilibrium after a period of time. In an attempt to halt the decline of the water table, no new permits to drill irrigation wells in this area will be considered by the State of Washington; and if necessary, the state will close those irrigation wells pumping without a permit. Some 31,000 acres using ground water do not have an adequate supply.

## Application of Water

Both sprinkler and gravity systems are used in Subregion 2, with sprinkler application being used on almost 45 percent of the irrigated lands and increasing in importance each year. Sprinkler irrigated acreage on the Columbia Basin Project has increased from 25 percent of the irrigated acreage in 1959 to 40 percent in 1967.

Orchards in the Chelan-Okanogan subarea are almost exclusively irrigated by hand-move sprinkler systems. The border strip method of gravity irrigation is dominant in the Big Bend subarea. Sprinkler

irrigation in this subarea is characterized by the mechanical wheel-move systems including the pivotal systems which are becoming popular for the more recently developed lands. Irrigation practices in the Ferry-Stevens subarea are typified by wild flooding during the spring months and sprinkling with hand-move systems for those who have a late season water supply.

### Quality of Water

The quality of surface and ground water for irrigation is excellent. There is little change in the mineral content of the main stem of the Columbia River from the point where it enters the subregion to the Snake River confluence. This is due in part to the tributary streams and also to the balance of input created by more mineralized streams being offset by less mineralized streams. Many years of continuous use and analysis of samples have shown that the subregion's waters are neither harmful to soils nor to crops. Irrigation has had a minimal effect on the quality of water in the tributary streams.

Sedimentation rates range from low to medium yields, with the majority of the streams considered to have low rates. The upper reaches of Crab Creek and the upper Wenatchee River occasionally experience local sediment problems.

## FUTURE NEEDS

Substantial development of new irrigated land will be required to meet future regional food and fiber requirements. Nearly all the crops grown in the region are adapted to this subregion. In the future considerable amounts of the potatoes, fruits, sugar beets, hay, and vegetables produced in the region are expected to come from Subregion 2.

### Lands

The determination of future irrigated acreage needs was based primarily on the satisfaction of food and fiber requirements. In addition, consideration was given to scheduled and anticipated state, Federal, and private developments.

In 1966 there were 729,000 irrigated acres in the subregion. In order to satisfy projected needs, this acreage will have to increase to 1,280,000 acres by 1980, to 1,490,000 by the year 2000, and to 1,920,000 by 2020. A large part of the 1980 need can be satisfied by irrigation developments which have already been

authorized by Congress but as yet have not been funded. Irrigated area needs are presented in table 40.

Table 40 - Irrigated Area Needs by 1980, 2000, and 2020, Subregion 2

| Item | Irrigated Acreage 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|
| Harvested cropland and pasture 1/ | 1,088 | 1,266 | 1,632 |
| Other 2/ | 192 | 224 | 288 |
| Total irrigated area | 1,280 | 1,490 | 1,920 |

1/ From table 41.
2/ Includes irrigated forest, range, rights-of-way, ditches, roadways, farmsteads, urban, and idle irrigated lands not used in the production of projected crop requirements.

The irrigated area needs are based on requirements for productive irrigated land adjusted to include other irrigated lands not used in the production of crops and pasture. Productive irrigated land consisting of irrigated cropland harvested and pasture are identified by crop categories in table 41.

Table 41 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020, Subregion 2

| Crop Category | Acreage Needs 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|
| Small grains | 344 | 341 | 431 |
| All hay | 338 | 419 | 547 |
| Dry beans and peas | 60 | 67 | 79 |
| Sugar beets | 78 | 119 | 173 |
| Potatoes | 56 | 66 | 85 |
| Vegetables | 13 | 15 | 17 |
| Fruits, nuts, and berries | 43 | 43 | 48 |
| Forage seed, hops, and mint | 19 | 21 | 27 |
| Pasture | 91 | 110 | 142 |
| Unenumerated | 56 | 65 | 83 |
| Total | 1,088 | 1,266 | 1,632 |

Forage and feed crops are expected to continue as major users of irrigated land. Irrigated agriculture in this subregion is expected to remain quite diverse with relatively large acreages of each represented crop category.

## Production and Yield

A summary of crop production from irrigated land is presented in table 42. Crop yields by crop category are shown on figure 15. The yields are presented in index form and represent the percentage increase, with the yields realized in 1964 set at a base of 100.

Table 42 - Crop Production from Projected Irrigated Acreage for 1980, 2000, and 2020, Subregion 2

| Crop Category | Units | Production 1980 (1000's) | Production 2000 (1000's) | Production 2020 (1000's) |
|---|---|---|---|---|
| Small grain | tons | 1,004 | 1,363 | 2,072 |
| Hay | tons | 1,880 | 2,841 | 4,308 |
| Dry beans and peas | cwt. | 1,710 | 2,356 | 3,342 |
| Sugar beets | tons | 2,367 | 3,933 | 6,099 |
| Potatoes | cwt. | 25,457 | 36,122 | 52,617 |
| Vegetables | cwt. | 1,902 | 2,500 | 3,599 |
| Fruits, nuts, and berries | tons | 485 | 724 | 1,041 |
| Forage seed, hops, and mint | lbs. | 5,666 | 7,892 | 12,829 |

## Value of Production

Projected values of irrigated crop production are based on the same price structure used by the Office of Business Economics and the Economic Research Service (OBERS) in the regional projections. A summary of projected values of crop production is presented in table 43.

## Water

By 2020, it is expected that water delivered to farms in Subregion 2 will be about 3.7 million acre-feet more than the 2.9 million acre-feet delivered in 1966. Depletions resulting from the new water deliveries will amount to about 2.3 million acre-feet annually. Estimated farm deliveries and depletions are shown by time periods in table 44.

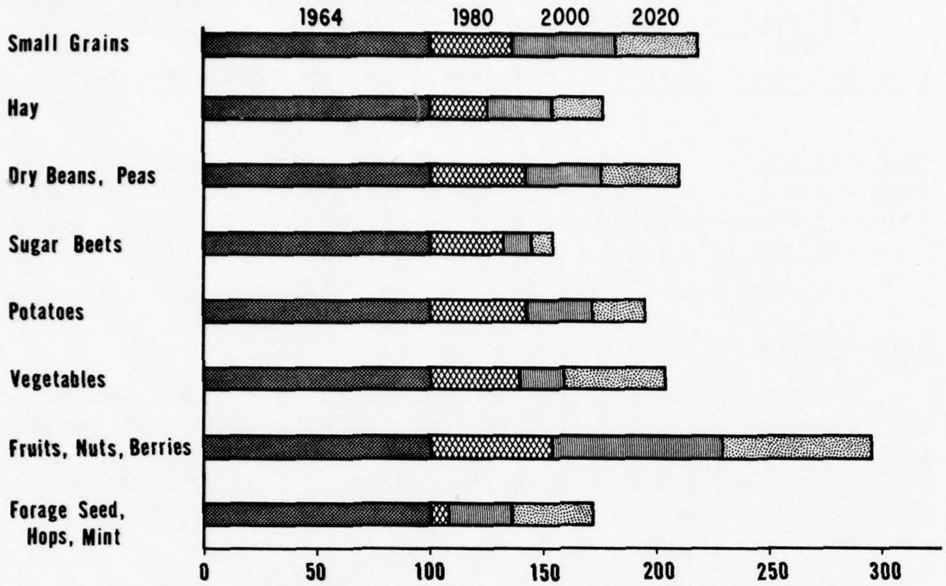



FIGURE 15. Projected Crop Yields in 1980, 2000, and 2020 for Selected Crops (1964 as Base Year Equals 100), Subregion 2.

Table 43 - Value of Projected Irrigated Crop Production, Subregion 2

| Crop Category | Value of Production 1/ 1980 | 2000 ($1000) | 2020 |
|---|---|---|---|
| Small grains | 53,100 | 72,100 | 109,600 |
| Hay | 40,400 | 61,100 | 92,600 |
| Dry beans and peas | 8,900 | 12,500 | 17,900 |
| Sugar beets | 27,200 | 45,200 | 70,200 |
| Potatoes | 34,100 | 48,400 | 70,500 |
| Vegetables | 5,600 | 7,400 | 10,700 |
| Fruits, nuts, and berries | 58,600 | 87,500 | 125,800 |
| Forage seed, hops, and mint | 1,200 | 1,600 | 2,700 |
| Total | 229,100 | 335,800 | 500,000 |

1/ Based on projected normalized prices.

Table 44 - Projected Farm Deliveries and Depletions, Subregion 2

| Year | Presently Irrigated Farm Delivery | Presently Irrigated Depletion | Future Irrigation Farm Delivery | Future Irrigation Depletion | Total Farm Delivery | Total Depletion |
|---|---|---|---|---|---|---|
| | | | (1,000 acre-feet) | | | |
| 1966 | 2,916 | 2,690 | | | 2,916 | 2,690 |
| 1980 | 2,910 | 2,500 | 1,820 | 1,430 | 4,730 | 3,930 |
| 2000 | 2,770 | 2,200 | 2,510 | 1,980 | 5,280 | 4,180 |
| 2020 | 2,630 | 1,900 | 3,970 | 3,050 | 6,600 | 4,950 |

## Supplemental

Water supply problems are generally of a local nature. Of the 37,000 acres in need of supplemental water, most are scattered in small tracts throughout the subregion. The only large concentration of land in need of additional water is a block of 4,600 acres near the towns of Omak and Okanogan in the Chelan-Okanogan subarea.

Irrigated lands east of the Columbia Basin Project in Adams, Lincoln, and Grant Counties, which are growing small grains, have an adequate water supply for that purpose but not for the projected diversified cropping. The present supply for these 31,000 acres is from wells but the further development of ground water in this area has been restricted. In order to grow crops other than small grains, present water supplies would have to be supplemented from sources outside this general area.

The diversion required to provide the supplemental water needed in the subregion is estimated to total 63,000 acre-feet, as shown in table 45. This would require a farm delivery of about 45,000 acre-feet and result in a depletion of 30,000 acre-feet.

Table 45 - Supplemental Irrigation Diversion Requirements, Subregion 2

| Subarea | Water-Short Lands | Supplemental Requirement |
|---|---|---|
| | (acres) | (acre-feet) |
| Ferry-Stevens | 1,000 | 1,000 |
| Chelan-Okanogan | 5,000 | 2,000 |
| Big Bend | 31,000 | 60,000 |
| Total | 37,000 | 63,000 |

Present farm efficiencies are somewhat low in the subregion. With the trend toward sprinkler irrigation, it is expected that farm efficiencies will improve and farm losses will decrease. By 1980, the decrease in farm losses is expected to be about equal to the amount of supplemental farm deliveries provided for lands with an inadequate water supply. Consequently there will be no significant change in total farm deliveries by 1980. It is expected that farm efficiencies will continue to improve after 1980, resulting in somewhat smaller total farm deliveries to presently irrigated lands by 2000 and 2020.

About 800,000 acre-feet of the present annual depletion results from return flows building up the ground water table. It is expected that this return flow loss will gradually decrease and that the water table will reach equilibrium by 2020.

Full

Following present trends in irrigation development in the subregion, it is anticipated that most future irrigation will utilize sprinkler application. Consequently the estimated unit farm delivery figures reflect this method of irrigation. Requirements by year 1980 and even to year 2000 reflect the diversified cropping as is presently practiced. For more distant future developments, as for years between 2000 and 2020, it is estimated that there will be more intensive use of irrigable land with resultant increased crop irrigation requirement for water. Such use, however, is not expected to result in a significant change in unit depletions per acre of irrigated land because increased efficiency of water application is expected under those conditions. Farm deliveries for the newly irrigated lands in 2020 will total 3,970,000 acre-feet. Depletions will total 3,050,000 acre-feet. Table 46 shows anticipated unit streamflow depletions and estimated farm deliveries.

Table 46 - Irrigation Requirements and Use, Subregion 2

| Subarea | Present-2000 Farm Delivery (AF/ac.) | Present-2000 Depletion (AF/ac.) | 2000 - 2020 Farm Delivery (AF/ac.) | 2000 - 2020 Depletion (AF/ac.) |
|---|---|---|---|---|
| Big Bend | 3.3 | 2.6 | 3.4 | 2.5 |
| Ferry-Stevens | 2.8 | 2.2 | 3.1 | 2.3 |
| Chelan-Okanogan | 3.1 | 2.5 | 3.2 | 2.4 |

## THE POTENTIAL TO MEET THE NEEDS

There are more than 14 million acres of land in Subregion 2. Of this amount, nearly 3 million acres or approximately one-fifth are presently nonirrigated and classified as *potentially irrigable*. About 82 percent of this potential is located in the Big Bend subarea, 13 percent in the Ferry-Stevens subarea, and 5 percent in the Chelan-Okanogan subarea.

The area has several favorable assets for irrigation; these include substantial quantities of irrigable land and high quality water, favorable climatic conditions, fertile soils, fairly accessible water supplies, a tradition of quality irrigated crops, relatively low-cost hydroelectric power supplies for irrigation pumping, and market demand for agricultural commodities produced.

### Potentially Irrigable Lands

The subregion is characterized by wide differences in soils and topography. Most of the potentially irrigable lands are dry-farmed or grazed and will require little or no land clearing. However, there are some forested areas having irrigation potential in the Chelan-Okanogan and Ferry-Stevens subareas.

Soils range from the shallow, cobbly, glacial soils of the mountains and irrigated valleys to the deep, loessal soils of the Big Bend area.

Slopes range from nearly level in the bottom lands to moderately steep in the uplands.

The potentially irrigable land has been identified and grouped into three land classes according to specifications developed by state and Federal agencies involved in this study. Table 47 shows the acreage and distribution of class 1, 2, and 3 lands.

Table 47 - Potentially Irrigable Land, Subregion 2

| Subarea | Class 1 | Class 2 | Class 3 | Total |
|---|---|---|---|---|
| | | (acres) | | |
| Big Bend | 419,900 | 879,640 | 1,144,750 | 2,444,290 |
| Ferry-Stevens | 19,530 | 187,970 | 169,400 | 376,900 |
| Chelan-Okanogan | 11,790 | 49,200 | 89,310 | 150,300 |
| TOTAL | 451,220 | 1,116,810 | 1,403,460 | 2,971,490 |
| Rounded | 451,200 | 1,116,800 | 1,403,500 | 2,971,500 |
| Percent of total | 15 | 38 | 47 | 100 |

*Sugar beets raised on irrigated lands in the subregion are transported to a refinery for processing. Rail and freight facilities transport the subregion's products to markets throughout the West. (Bureau of Reclamation)*

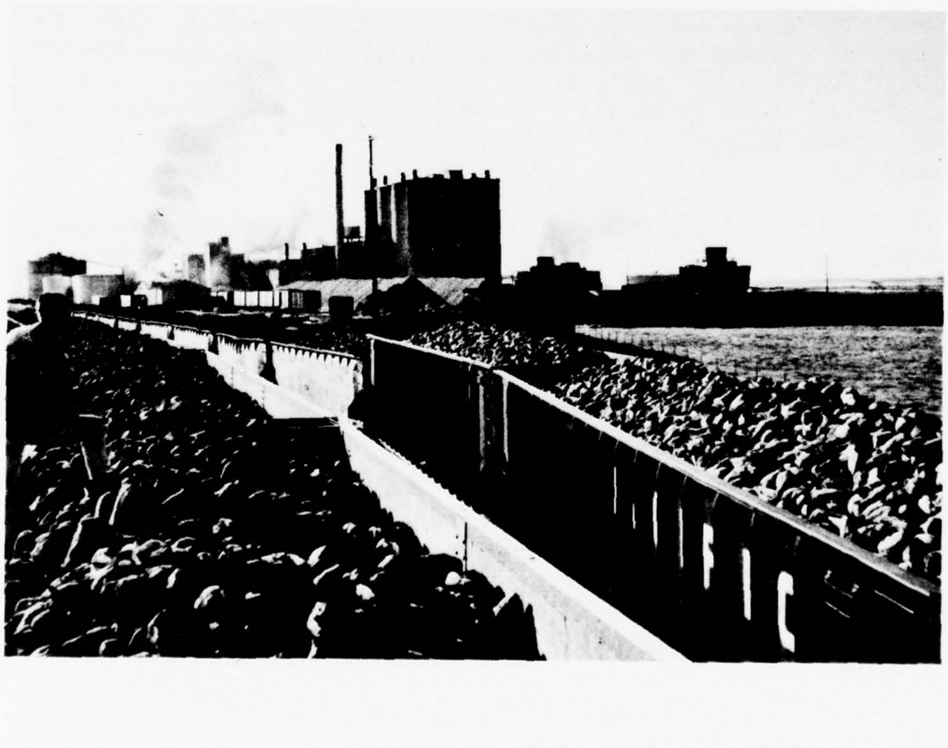


Figure 16 shows the location of the potentially irrigable lands by land classes. A brief description of the characteristics of each land class follows.

Class 1

About 451,200 acres have been placed in this category and comprise 15 percent of the potentially irrigable area.

These lands are highly productive and have only slight limitations for irrigation development. Soil depths range from 40 inches for soils of glacial origin to up to 10 feet or more in the loessal soils of the Big Bend subarea.

Surface textures are generally silt loams, but also include fine sandy loams, loams, and friable clay loams. Gravel and cobble are common in the glacial soils but are not in sufficient quantities to cause tillage problems.

These soils are generally well drained and free from harmful salts. Very few slick spots or areas of salt concentrations occur. Slopes are nearly level and these soils are well suited to gravity irrigation where they occur in the valley bottoms and on valley terraces. Many class 1 soils occur on the rolling lands on ridge tops and sprinkler irrigation is more practical in these areas.

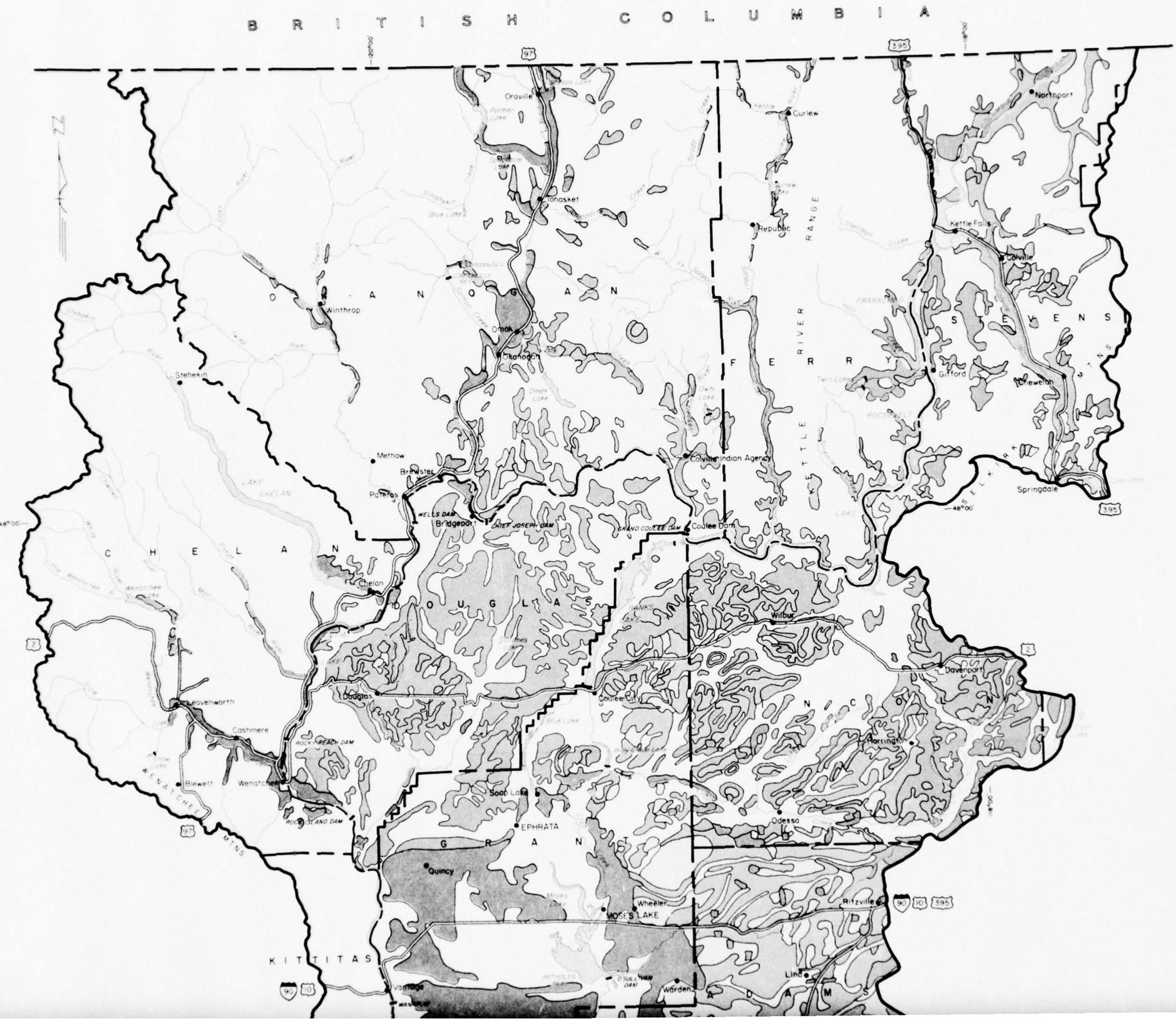
Class 2

There are about 1,116,800 acres of good quality class 2 lands, 38 percent of the total potentially irrigable acreage, having moderate limitations for irrigation development. About 79 percent of these lands are located in the Big Bend subarea; however, the highest proportion of class 2 land is in the Ferry-Stevens subarea.

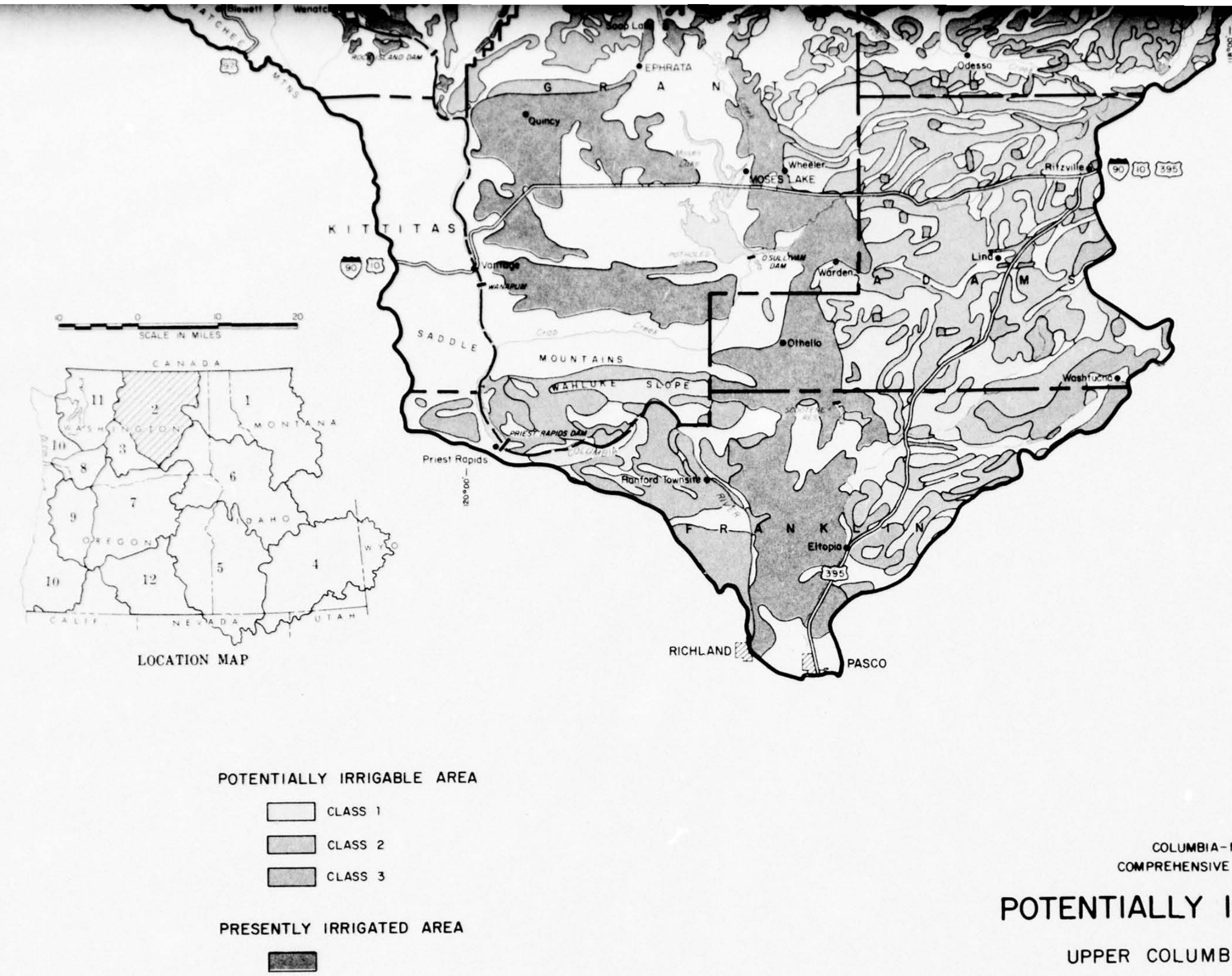
Slope and depth of the soil are the most common limitations. Slopes may range up to 12 percent and the soil depth may be as shallow as 20 inches.

Loams and silt loams are the most common surface textures. Gravelly and cobbly surfaces are common for soils of glacial origin; however, these soils could be farmed with few, if any, tillage problems.

Most class 2 soils are well suited to sprinkler irrigation and moderately well suited to gravity irrigation.



BRITISH COLUMBIA
OKANOGAN
FERRY
STEVENS
CHELAN
DOUGLAS
LINCOLN
GRANT
ADAMS
KITTITAS
KETTLE RIVER RANGE
SELKIRK MTNS
WENATCHEE MTNS
Oroville
Tonasket
Omak
Okanogan
Winthrop
Methow
Brewster
Pateros
Bridgeport
Stehekin
Chelan
Leavenworth
Cashmere
Wenatchee
Blewett
Curlew
Republic
Kettle Falls
Colville
Northport
Gifford
Chewelah
Springdale
Colville Indian Agency
Coulee Dam
Coulee City
Wilbur
Davenport
Harrington
Odessa
Douglas
Soap Lake
EPHRATA
Quincy
Wheeler
MOSES LAKE
Ritzville
Lind
Warden
Vantage
WELLS DAM
CHIEF JOSEPH DAM
GRAND COULEE DAM
ROCKY REACH DAM
ROCK ISLAND DAM
O'SULLIVAN DAM
LAKE CHELAN
97
395
2
90
10
120°00'
118°00'
48°00'




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# POTENTIALLY IRRIGABLE AREA

UPPER COLUMBIA, SUBREGION 2

1968

FIGURE 16

2

Class 3

There are about 1,403,500 acres in class 3, which represent 47 percent of the total potentially irrigable acreage. The Big Bend subarea contains 82 percent of this acreage.

These lands have more severe limitations for irrigation development than class 2 land, the dominant limitations being shallow soils and steep slopes that tend to reduce irrigation efficiency.

Class 3 lands occur in the rolling upland areas and the steeper foothill areas. Soil depths range from 10 to 20 inches and cobbly, gravelly surfaces often occur that make cultivation of row crops impractical. Sprinkler irrigation will be required on much of these uplands. Bottom land areas of the mountain valleys, although not extensive, are somewhat poorly drained; however, water tables can be maintained below 18 inches for most of the growing season. Crops in these areas may be damaged by occasional floods. Many of these lands can be successfully irrigated using gravity methods.

## Water Supply

An average of about 79 million acre-feet enters the subregion and 83 million acre-feet leaves it. Thus net discharge originating in the subregion averages about 4 million acre-feet per year. The net discharge reflects consumption of about 1.4 million acre-feet of surface runoff.

Storage in the uppermost 50 feet of the ground water reservoir is estimated to be about 35 million acre-feet. Annual natural recharge is about 6 million acre-feet annually.

## Potential Developments

To meet long range needs of 2020, a dependable water supply will have to be developed for an additional 1,190,000 acres. In addition, 37,000 acres presently irrigated with an inadequate water supply must be provided with a full supply.

There are about 3 million potentially irrigable acres in the subregion which are primarily in large blocks and are best suited to project-type development. Of the 729,000 acres currently irrigated, about one-third were developed through private enterprise. Private enterprise will continue to develop irrigable lands in the subregion, either as private or corporate developments; however, it is anticipated that most of the long-range irrigation development will be by Federal agencies.

## Development by Subarea

Chelan-Okanogan About 150,000 acres of potentially irrigable land are scattered throughout this subarea. To help meet the needs of the subregion, development in this subarea would have to occur mainly in the Okanogan River basin and along the Columbia River. Further expansion in the Okanogan River basin would depend on the construction of storage on the Okanogan River or its tributaries. Pumping to offstream storage during periods of high flow is also a possibility. Any plan involving control of the upper reaches of the river would require the cooperation and assistance of the Canadian Government.

Lands in the proximity of the Columbia River could be served by pumping from the river. Lifts of 300 to 1,000 feet would probably be required.

Big Bend The largest potential for irrigation development in the subregion exists in this subarea. Much of the 2.4 million acres of potentially irrigable land in this subarea which can be developed has significant acreages of class 1 and class 2 lands. Since streamflows originating in the subarea are extremely meager, the Columbia River will be the logical source of water supply for any significant future irrigation development.

Ferry-Stevens There are some 376,000 acres of potentially irrigable land scattered throughout this two-county subarea. Lands along the Columbia River could be served by pumping from Franklin D. Roosevelt Lake or Columbia River tributaries. Some potentially irrigable lands in the Colville area could be served by pumping from the Colville River if storage is provided. Irrigation in the Ferry-Stevens subarea is restricted by the lack of suitable land resources and generally not the water resource. Climate limits crop diversification.

## Private Development

In Franklin, Lincoln, Grant, and Adams Counties, the State of Washington recognized that large ground water developments are occurring. On the basis of past trends of irrigation in this area, the State estimated that about 50,000 acres could be developed by private initiative. Ground water development in other sections of the subregion will probably be limited.

The use of unregulated surface flows in this subregion has reached the point where they are not sufficient to permit private enterprise to irrigate sizeable areas of new lands. Pump lifts are also excessive in most areas which limits development of lands through private initiative.

Federal Development

The most obvious remaining Federal development would be the irrigation of the remainder of the originally contemplated million-acre Columbia Basin Project. Most of these lands are situated to the east of the presently irrigated lands and along the Wahluke Slope to the west of the project.

There are other large blocks of land in the Big Bend subarea which could be developed by using Columbia River flows. A large block of land east of Banks Lake contains some 360,000 potentially irrigable acres. The primary source of water for these lands would be pumping from Lake Roosevelt with Banks Lake serving as an intermediate storage facility. The pump lifts to serve this area would range from 600 to 1,200 feet. In addition, there are approximately 450,000 acres of irrigable land in a relatively uniform block west of Banks Lake which could be served by pumping from Lake Roosevelt with lifts from 700 to 1,200 feet. Banks Lake would also likely serve as an intermediate storage facility for this block of land.

There are some 450,000 acres of potentially irrigable land located east of the Columbia Basin Project in the vicinity of Odessa and Washtucna. The plan of development would probably include joint use of portions of the water supply system required for the lands east of Banks Lake. These lands are generally at lower elevations than those on both sides of Banks Lake. Some of the lands to the south could be served by diversions from the Palouse River which lies to the east in Subregion 6.

An area containing about 420,000 acres of potentially irrigable land is located in the northeast portion of the Big Bend subarea. Much of this area can be irrigated by pumping from the Columbia or Spokane Rivers. The pump lifts required would range from 1,000 to 1,200 feet.

There are 15,000 acres of potentially irrigable land in the Wahluke Slope area north of the Columbia River and 110,000 acres south of the river that are located in the U. S. Atomic Energy Commission Reservation. The development of these lands will depend on future Atomic Energy Commission policies.

Federal development of irrigation in the Ferry-Stevens subarea will be restricted by the lack of sizeable blocks of potentially irrigable land rather than an available water supply.

Recent surveys on the Colville Indian Reservation have identified two land areas totaling about 47,000 potentially irrigable acres. Water can be made available to these lands by pumping from the Okanogan, Columbia, and San Poil Rivers.

Several Federal projects are located in the Chelan-Okanogan subarea. Storage and pumping from the Okanogan and Columbia Rivers are being considered as probable water supplies. Plans are also under development at the Federal level to rehabilitate and modernize various existing projects in this subarea.


LOCATION MAP

# SUBREGION 3

# YAKIMA

## THE SETTING

The Yakima Subregion, located in south-central Washington, covers an area of 6,062 square miles, slightly more than 2 percent of the total region. It is a roughly triangular-shaped area having the Cascade Range to the west and semi-arid uplands on the north and south. In addition to the Cascade Mountains, the Wenatchee Mountains, Rattlesnake Hills, and Horse Heaven Hills are the prominent physiographic features. Topography is characterized by a series of long, rather hilly ridges extending to the east from the Cascades and encircling flat valley areas.

The Yakima River and its tributaries drain the subregion. The Yakima River heads near the crest of the Cascade Range, northeast of Mt. Rainier, and flows for 180 miles in a generally southeast direction to its confluence with the Columbia River near Richland. It is the largest single river system located entirely within the State of Washington. Major tributaries include the Naches, Cle Elum, Kachess, and Teanaway Rivers.

The subregion has a substantial range in average annual amounts of precipitation. The mountainous western headwater areas receive up to 100 inches of precipitation annually; the lower eastern areas receive about 7 inches. Summers are hot and dry in the valley areas; most of these areas have frost-free seasons of 140 to 200 days.

Major climatic influences producing the dry conditions are elevation, continental location, the "rain shadow" effect of the Cascade Range, and the drought-producing effect of a subtropical high pressure system located along the Oregon-Washington coast during the summer season. Their influence on variations in effective precipitation is reflected in natural vegetative types; the higher precipitation areas have a forest cover, and the lower areas support drought-resistant grasses and sagebrush.

This subregion has been characterized as an agricultural area from earliest settlement. Settlement of the Yakima Valley increased rapidly following the Civil War. An important point in agricultural history occurred in 1886-88 when the Northern Pacific Railroad's transcontinental line reached Yakima and opened populous market areas to the farmers.

Presently, in addition to the railroads, a network of highways and commercial air service connects the subregion to other portions of the region and the Nation.

Population densities are high in the agricultural area and low in the adjacent rangelands. Principal communities include Yakima, Richland, Ellensburg, Sunnyside and Toppenish, all of which are located on the Yakima River.

For discussion purposes, the subregion has been divided into two valleys: (1) the Kittitas Valley, which encompasses a major portion of Kittitas County and the upper portion of the Yakima River drainage; and (2) the Yakima Valley, which encompasses a major portion of Yakima and Benton Counties and a small portion of Klickitat County and the remainder of the Yakima River drainage. The county line between Kittitas and Yakima Counties is the boundary between the two valleys. See figure 17.

Irrigation in the subregion began during the late 1840's. The first known facility constructed specifically for irrigation was a ditch diverting water from Ahtanum Creek in 1864. Three years later, farmers were diverting water from the Naches River. The early irrigation systems were privately constructed and served easily accessible lands along the main stem of the Yakima River and the lower portions of the major tributaries.

The early settlers experimented with a variety of irrigated agricultural crops. These early trials had an important bearing on the present economy of the subregion. A significant step in establishing fruit crops came in 1870 when apple and pear trees were planted on a farm near Yakima.

The railroad's large land grant acreages were used to promote investments in irrigation to attract settlers and to encourage the exporting of crops.

Irrigation increased rapidly, and by the early 1900's the Yakima Valley was the most extensively irrigated area in Washington. However, the Yakima River's natural flow water supply was over-appropriated and further expansion of the irrigated acreage without storage was not practical.

The Reclamation Act of 1902 made Federal funds available for investigation and development of irrigation projects. In 1903 the Secretary of the Interior was requested to investigate the irrigation development potential of the Yakima River basin. Studies were started in 1905 on plans to provide for an adequate irrigation water supply for lands needing supplemental water and also for expansion of the irrigated acreage. In 1900 there were about 67,000 acres irrigated; in 1905, when Reclamation Service studies were

started, there was private development of 125,000 acres with serious limitations on further expansion. Irrigation water was available from the Yakima Project for the 1907 growing season.

*Irrigating orchards has been an important type of agriculture in the Yakima subregion for many years. The license plate on the car is for the year 1917. (Bureau of Reclamation)*

Irrigation has played a vital role in development of other segments of the economic framework. For example, an essential marketing need of irrigated orchards was specialized boxes and containers; in response to this requirement, an important lumbering associated industry was developed to provide the basic materials to box and container factories.

Early development of a railroad system into the irrigated areas and the later impact of a flexible trucking industry have greatly expanded the market potential of the commercial farms. The subregion has a good transportation network served by many forms of commercial transportation. Improved processing and storage techniques have permitted use of these transportation facilities

throughout the year to meet off-season demands for high quality specialty crops.

## PRESENT STATUS

Irrigated agriculture and related industries are the major economic activities in this subregion and their importance is far reaching. According to 1964 Census of Agriculture data, Yakima County ranked 15th in the Nation in total value of agricultural production. This was the highest national ranking of any county in the region. Table 48 lists the irrigated acreage by source of supply, method of irrigation and adequacy of supply.

Table 48 - Irrigated Area, 1966, Subregion 3

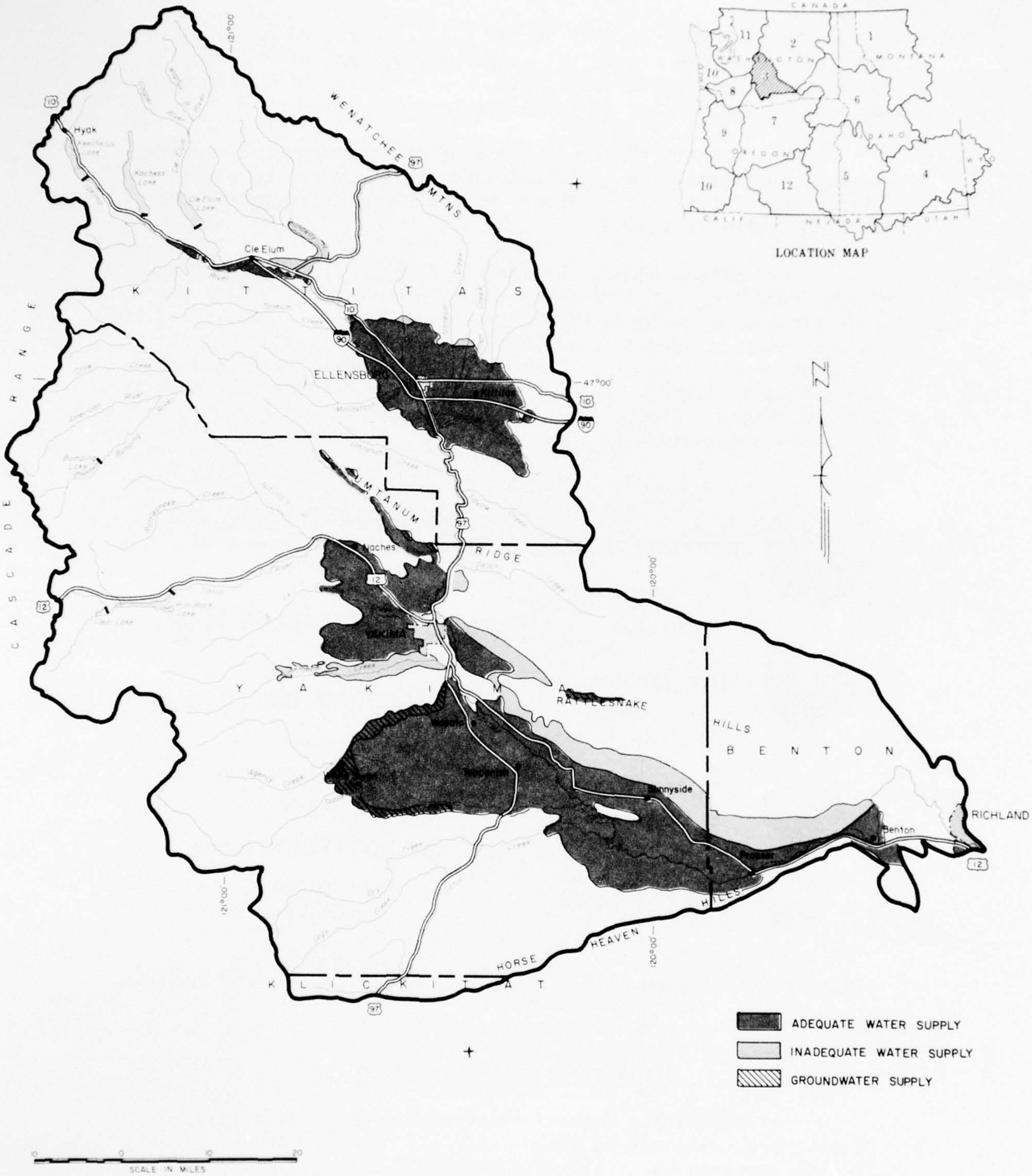
| Source of Supply | | Adequacy of Supply | | Method of Irr. | | |
|---|---|---|---|---|---|---|
| Surface | Ground | Adeq. | Inadeq. | Sprinkler | Gravity | Total |
| | | | (Acres) | | | |
| 487,000 | 18,000 | 399,000 | 106,000 | 102,000 | 403,000 | 505,000 |

### Characteristics of Irrigated Areas

By 1966 there were 462,000 acres irrigated in the Yakima Project and 63,000 acres privately developed. Approximately 20,000 acres of these lands lie outside of the subregion. This expansion has been made possible by construction of Federal facilities including six major storage dams and reservoirs providing about 1,070,000 acre-feet of active storage capacity.

Irrigation development has taken place in both valley areas. Lands in the Kittitas Valley support primarily irrigated pasture and livestock enterprises. The Yakima Valley produces almost all of the fruit grown in the subregion. Included in the irrigated area is a small acreage in irrigated forest nurseries and seed orchards, recreation sites, and minor tracts used for wildlife and other nonagricultural purposes.

Most of the lands receive a water supply from storage facilities. About 487,000 acres are served from surface water and 18,000 acres are served from ground water. In addition, 20,000 acres located southeast of Kennewick in Subregion 7 receive a water supply from the lower Yakima River. Figure 17 shows the location of irrigated lands within the subregion.




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# IRRIGATED AREA

YAKIMA, SUBREGION 3

1968

FIGURE 17

More than 40 percent of the lands identified as suitable for irrigation are presently irrigated, and the value of agricultural production from these lands highlights the subregion as a major agricultural area in the region.

According to the 1964 Census of Agriculture, there were about 7,000 farms with irrigated land; this number represents about 95 percent of all farms. The average farm with irrigated land had about 65 acres irrigated.

Most of the acreage devoted to fruit, vegetable, and nongrain field crops is irrigated. Dairy and other livestock farms that produce all or most of their own forage have a portion of the farm acreage devoted to irrigated pasture and hayland. Poultry and cash-grain field crop farms are the only farm types generally nonirrigated; however, a small number of grain farms have some irrigated acreages. Figure 18 shows acreages irrigated for cropland harvested and pasture in Subregion 3.

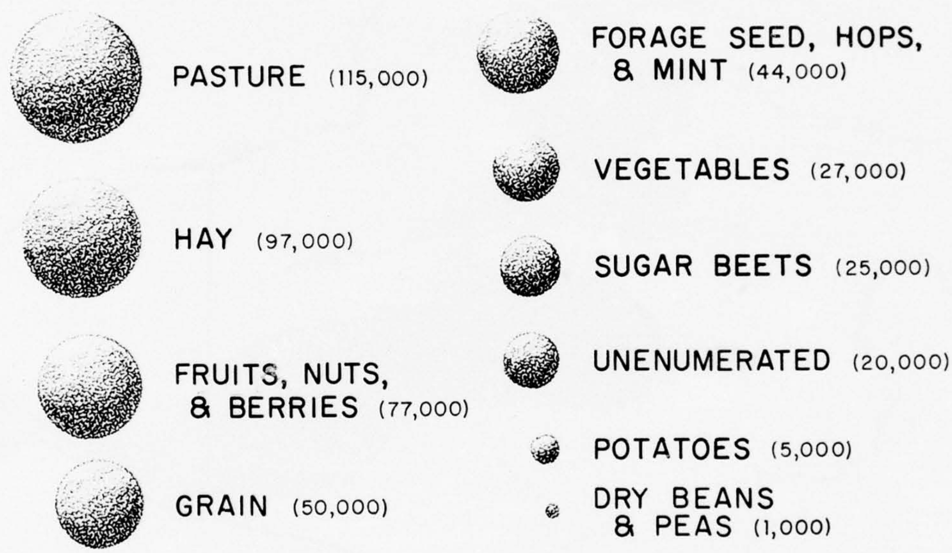



FIGURE 18. Acreage of Irrigated Cropland Harvested and Pasture, 1964, Subregion 3.

## Production of Irrigated Crops

Irrigation has enabled successful production of a number of crops which could not be grown under dry farming methods and has greatly improved the yield of those which could be grown without it. This favorable situation results in the subregion ranking high

as a producer of major irrigated crops in the region. For example, in 1964 the subregion produced the following percentages of several of the region's high value cash crops: grapes (94), hops (86), asparagus (75), apricots (64), peaches (60), Bartlett pears (47), mint (47), and apples (37). The subregion is also an important cattle feeding area and it produced 17 percent of the cattle feeding grain or concentrate sold in the region in 1964.

The production of several irrigated crops was important nationally as well. In 1964 the subregion produced 64 percent of the hops, 37 percent of the mint, 10 percent of the sweet cherries and asparagus, and 8 percent of the apples.

Production of irrigated crops is compared with total production by crop category in table 49 with yields of selected crops following in table 50. About half of the small grain production comes from irrigated land. About 97 percent of hay production is grown under irrigation as is virtually all production from the remaining categories.

Table 49 - Summary of Crop Production, 1964, Subregion 3

| Crop Category | Units | Production (1000's) Total | Production (1000's) Irrigated | Percent Irrigated |
|---|---|---|---|---|
| Small grains | tons | 185 | 93 | 50.3 |
| All hay | tons | 325 | 315 | 96.9 |
| Dry beans and peas | cwt. | 10 | 10 | 100.0 |
| Sugar beets | tons | 564 | 564 | 100.0 |
| Potatoes | cwt. | 1,245 | 1,245 | 100.0 |
| Vegetables | cwt. | 2,007 | 2,007 | 100.0 |
| Fruits, nuts, and berries | tons | 461 | 459 | 99.6 |
| Forage seed, hops, and mint | lbs. | 41,747 | 41,722 | 99.9 |

Source: Derived from Census of Agriculture and Agricultural Statistics

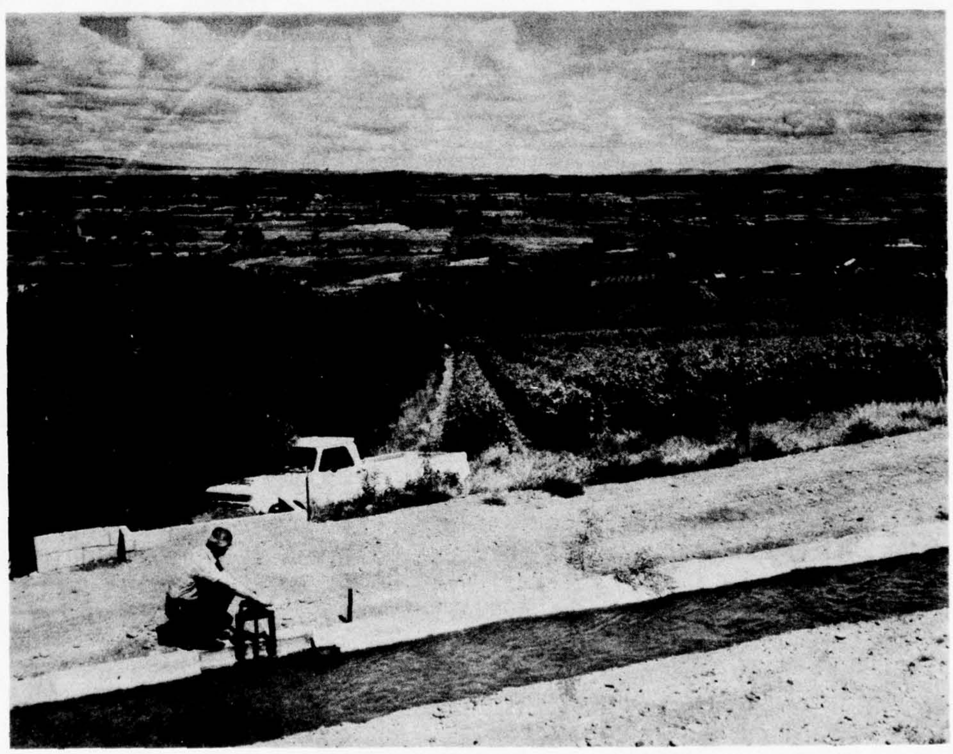
In addition, the amount of production of irrigated feed crops indicates that about 76 percent of total livestock requirements are met by feeds from irrigated land. This estimate excludes feed crops exported from the subregion.

## Value of Production

Crop and livestock production associated with irrigation was valued at $115 million in 1964. Irrigated crops excluding

Table 50 - Yields for Selected Major Irrigated Crops, 1964, Subregion 3

| Crops | Units | Yield Per Acre |
|---|---|---|
| Small grains and hay | | |
| Wheat | tons | 1.86 |
| Barley | tons | 1.39 |
| Corn | tons | 2.41 |
| Alfalfa hay | tons | 3.50 |
| Field crops | | |
| Potatoes | cwt. | 257 |
| Sugar beets | tons | 22.5 |
| Mint oil | lbs. | 77 |
| Hops | lbs. | 1,730 |
| Vegetables | | |
| Sweet corn | tons | 6.1 |
| Asparagus | tons | 1.5 |
| Green peas | tons | 1.8 |



*Over half a million acres of irrigated land in the subregion produce high quality fruits, vegetables, grain, and forage crops. (Bureau of Reclamation)*

livestock feed fed accounted for more than $76 million. Livestock and livestock products associated with irrigation accounted for more than $38 million. Some important crop categories include fruit valued at over $44 million, field crops at nearly $26 million, and vegetables valued at $6 million.

## Economic and Social Impacts

Development of irrigation facilities has had a major impact on the total economy of the subregion. The gross value of products and services derived from irrigated farms associated with irrigated agriculture is shown in table 51. Irrigation use has greatly enhanced associated industries which created economic values more than double the value of sales of agricultural products. This enhancement has generated nearly double the man-years of employment associated with basic agriculture.

Table 51 - Gross Value of Agricultural Products and Services Associated with Irrigation Use, Subregion 3

| Industry | Gross Value ($1,000,000) |
|---|---|
| Basic agriculture | 115 |
| Processing | 93 |
| Trades and services | 185 |
| Total | 393 |

## Use of Water

The Yakima River is one of the most extensively developed of all rivers in Washington, and the largest use of water is for irrigation. Use of this resource has brought the area's fertile soils under successful sustained production of a variety of high value crops.

Sustained streamflows for irrigation are maintained in the Yakima River system during the dry summer season by operation of six major reservoirs. These reservoirs, features of the Yakima Project, retain natural runoff during the periods of water surplus for release during the irrigation season to provide for more adequate diversions downstream.

Irrigation diversions were estimated to total 2,465,000 acre-feet in 1966 for the irrigated lands in Subregion 3 and the 20,000

additional acres in Subregion 7. Return flows amounted to 1,325,000 acre-feet, resulting in depletions of 1,140,000 acre-feet.

Some 2,400,000 acre-feet of water are diverted annually from surface sources for irrigation. This is about equal to the average outflow from the subregion. Diversions include both the farm delivery requirement and the distribution system losses and waste. Of the total diversion, 100,000 acre-feet are used on 20,000 acres in Subregion 7. Table 52 shows estimated annual irrigation use of surface waters of the subregion.

Table 52 - Irrigation from Surface Water Sources, 1966 Level, Subregion 3

| Valley | Adequate Supply Area (acres) | Adequate Supply Diversion (ac-ft) | Inadequate Supply Area (acres) | Inadequate Supply Diversion (ac-ft) | Return Flow (ac-ft) | Depletion (ac-ft) |
|---|---|---|---|---|---|---|
| Kittitas | 94,000 | 430,000 | 18,000 | 60,000 | 300,000 | 190,000 |
| Yakima | 287,000 | 1,530,000 1/ | 88,000 | 380,000 | 990,000 | 920,000 1/ |
| Total | 381,000 | 1,960,000 | 106,000 | 440,000 | 1,290,000 | 1,110,000 |

1/ Includes 100,000 acre-feet for 20,000 acres in Subregion 7.
Source: Soil Conservation Service and Bureau of Reclamation data.

Annual withdrawal from ground water sources for irrigation amounts to about 65,000 acre-feet as shown in table 53. About 18,000 acres receive their primary source from ground water. In some cases, including the Ahtanum Valley, ground water is used to supplement inadequate surface supplies during periods of low natural runoff.

Table 53 - Irrigation from Ground-Water Sources, 1966 Level, Subregion 3

| Valley | Adequate Supply Area (acres) | Adequate Supply Diversion (ac-ft) | Inadequate Supply Area (acres) | Inadequate Supply Diversion (ac-ft) | Return Flow (ac-ft) | Depletion (ac-ft) |
|---|---|---|---|---|---|---|
| Kittitas | -- | -- | -- | -- | -- | -- |
| Yakima | 18,000 | 65,000 | -- | -- | 35,000 | 30,000 |
| Total | 18,000 | 65,000 | -- | -- | 35,000 | 30,000 |

Source: Soil Conservation Service and Bureau of Reclamation data.

Return flow from surface diversions is estimated to be 1,290,000 acre-feet annually or about 50 percent of surface diversions. Most of the water returns to the stream and is available for rediversion. Return flow from ground water withdrawal for irrigation is approximately 35,000 acre-feet annually.

The annual surface water depletion due to irrigation diversions is nearly 1,110,000 acre-feet, with 100,000 acre-feet of depletion due to diversion to lands outside the subregion. Some 30,000 acre-feet, or nearly one-half of the ground water withdrawal are depleted each year.

*Upstream storage such as Cle Elum Lake conserves streamflows for irrigation use and provides additional benefits to the economy through increased recreational opportunities and power generation. (Bureau of Reclamation)*

## Adequacy of Supply

Most of the lands that receive their water supply from storage reservoirs have an adequate water supply. For example, on the Yakima Project with a 1960 level of development, shortages would occur in only 7 years during a repetition of the period 1926 to 1960. The maximum shortage for the overall project would be

about 25 percent. The project's 72,500-acre Roza Division would bear the greatest proportion of shortage since it does not have a water supply comparable to other divisions of the project. It is estimated that the average annual shortage on the Roza Division would be 5 percent over the 35-year period, and as high as 55 percent in the worst year.

There are some low-lying valley lands in the subregion using unregulated natural flow that have severe shortages almost every year. One of these areas is in the Ahtanum Valley where about 12,000 acres are irrigated on both sides of Ahtanum Creek with those on the south side being within the Yakima Indian Reservation. Water shortages in this area have resulted in a long history of water disputes and court actions. A 1964 court decision gave most of the streamflow to Indian landowners on the south side of the creek. As a result, landowners of some 7,500 acres on the north side have average annual water shortages on their lands of up to 70 percent. In an effort to supplement their surface supply, several northside irrigators have developed wells. Also, even under the present decree, Indian lands face water shortages almost every year. For example, shortages would occur every year but one during a period such as 1910 to 1964. The development of storage on Ahtanum Creek and large scale ground water development could alleviate the water shortage problem in that area.

In addition to the Roza Division and the Ahtanum Valley areas, about 22,000 additional acres located throughout the subregion experience water shortages during periods of low runoff. This results in a total of 106,000 acres needing additional water. These lands are shown on figure 17. It is estimated that additional diversions of about 60,000 acre-feet annually would be required to provide them with an adequate water supply.

## Application of Water

Early irrigation farming was confined to gravity systems. Corrugations, border strips and flooding methods were used to irrigate the field crops and pasture. In the orchards and for some specialty crops, corrugations were almost exclusively used. These methods still predominate in the Yakima subregion.

In the past two decades sprinkler systems have become more important; presently, nearly 20 percent of the present irrigation is by this method. Hand-move systems are currently the primary means of sprinkler irrigation in the orchards. Side roll and hand-move systems are used in the forage and grain producing areas. Solid set systems are becoming more important in the production of grapes, hops, and asparagus. In the future sprinkler irrigation

is expected to increase in importance with continual emphasis on more sophisticated systems.

### Quality of Water

The quality of both surface and ground water is good for irrigation. Both sources have been used for irrigation for many years without harmful effects to soils or crops grown. They are characterized by low concentrations of dissolved solids, a low sodium adsorption ratio, low residual carbonates, and are devoid of toxic heavy metals.

Irrigation return flows have not seriously affected the water quality of the Yakima River system. Although mineralization increases over fourfold between the headwaters and the mouth, the water remains in the low salinity class and is suitable for reuse as irrigation water. In some areas where return flows are high in suspended solids, they settle and interfere with design flow capacity and in other instances cause wear of pumps and sprinklers. Where discharged to the Yakima River, these solids interfere with irrigation by settling behind diversion structures, requiring periodic removal.

## FUTURE NEEDS

The continued development of new irrigated land will be required if Subregion 3 is to contribute its full share of crop and livestock products needed by the Columbia-North Pacific Region. By 2020, 105,000 acres will have to be brought under irrigation. The water-short lands, totaling 106,000 acres, must also be provided with a full supply. Projections of production, land and water needs are presented in this section.

### Lands

The determination of future irrigated acreage needs is based on satisfying assigned food and fiber requirements. Additional considerations in selecting irrigation needs include availability of land and water, anticipated state, Federal, and private developments and other social and economic factors which affect irrigation expansion.

Future irrigated acreage needs are presented in table 54. Irrigated area needs increase from 505,000 acres in 1966 to 550,000 by 1980, 570,000 by the year 2000, and 610,000 acres by 2020. These figures are based on projected productive irrigated land

adjusted to include other irrigated lands not used in the production of crops and pasture.

Productive irrigated lands consisting of irrigated cropland harvested and pasture are identified by crop categories in table 55. Production of livestock feeds is a major use of irrigated land in this subregion but not to the extent in most other subregions. The quite diversified irrigated agriculture that now exists is expected to continue.

Table 54 - Irrigated Area Needs by 1980, 2000, and 2020, Subregion 3

| Item | Irrigated Acreage 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|
| Harvested cropland and pasture 1/ | 468 | 484 | 518 |
| Other 2/ | 82 | 86 | 92 |
| Total irrigated area | 550 | 570 | 610 |

1/ From table 55.
2/ Includes irrigated forest, range, rights-of-way, ditches, roadways, farmsteads, urban, and idle irrigated lands not used in the production of projected crop requirements.

Table 55 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020, Subregion 3

| Crop Category | Acreage Needs 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|
| Small grains | 114 | 109 | 73 |
| All hay | 78 | 82 | 97 |
| Sugar beets | 30 | 43 | 60 |
| Potatoes | 4 | 4 | 6 |
| Vegetables | 17 | 17 | 18 |
| Fruits, nuts, and berries | 68 | 63 | 68 |
| Forage seed, hops, and mint | 45 | 49 | 59 |
| Pasture | 94 | 98 | 116 |
| Unenumerated | 18 | 19 | 21 |
| Total | 468 | 484 | 518 |

## Production and Yield

A summary of crop production from irrigated land is presented in table 56. Crop yields are presented in index form on figure 19. The indexes are based on 1964 yields set at a common base of 100. A discussion of yield projections is presented in the Regional Summary.

Table 56 - Crop Production from Projected Irrigated Acreage for 1980, 2000, and 2020, Subregion 3

| Crop Category | Units | Production 1980 (1000's) | 2000 | 2020 |
|---|---|---|---|---|
| Small grain | tons | 286 | 345 | 276 |
| Hay | tons | 327 | 413 | 577 |
| Sugar beets | tons | 892 | 1,392 | 2,069 |
| Potatoes | cwt. | 1,455 | 1,751 | 2,972 |
| Vegetables | cwt. | 2,059 | 2,506 | 3,463 |
| Fruits, nuts, and berries | tons | 585 | 783 | 1,109 |
| Forage seed, hops, and mint | lbs. | 52,946 | 68,995 | 100,668 |

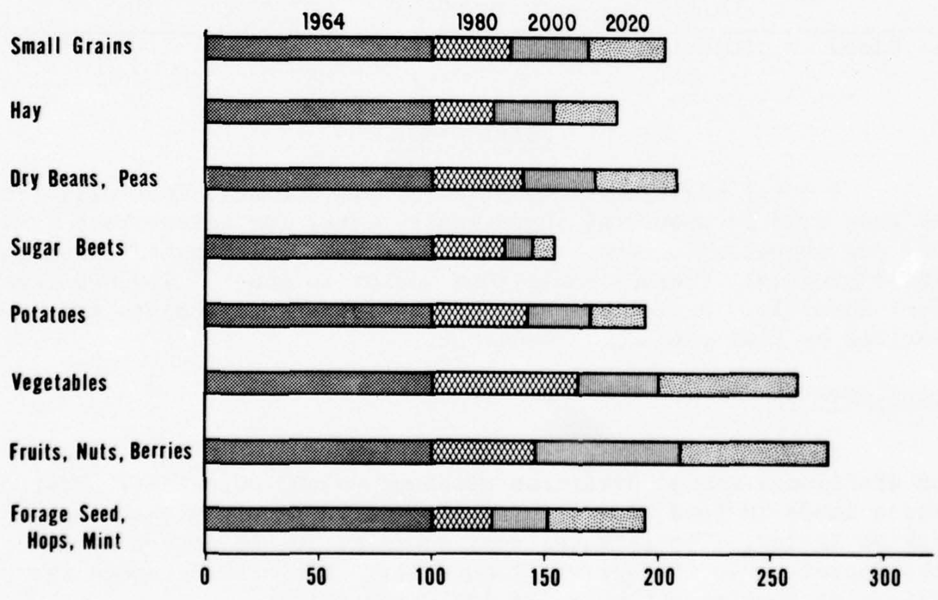



FIGURE 19. Projected Crop Yields in 1980, 2000 and 2020 for Selected Crops (1964 as Base Year Equals 100), Subregion 3.

## Value of Production

Values of projected irrigated crop production are presented in table 57. These values are inclusive of crops fed to livestock with the exception of pasture production. The same price structure used by the Office of Business Economics and the Economic Research Service (OBERS) in development of the regional food and fiber requirements were used here.

Table 57 - Value of Projected Irrigated Crop Production, Subregion 3

| Crop Category | Value of Production 1/ 1980 | 2000 ($1,000) | 2020 |
|---|---|---|---|
| Small grains | 15,100 | 18,200 | 14,600 |
| Hay | 7,000 | 8,900 | 12,400 |
| Dry beans and peas | - | - | - |
| Sugar beets | 10,300 | 16,000 | 23,800 |
| Potatoes | 1,900 | 2,300 | 4,000 |
| Vegetables | 6,100 | 7,400 | 10,300 |
| Fruits, nuts, and berries | 70,700 | 94,600 | 134,000 |
| Forage seed, hops, and mint | 11,000 | 14,300 | 20,900 |
| Total | 122,100 | 161,700 | 220,000 |

1/ Based on projected normalized prices.

## Water Needs

A total additional depletion of 310,000 acre-feet will result by year 2020 in providing supplemental water for water-short lands and new supplies for the projected increase of irrigated lands in the subregion. Present depletions amount to about 1,140,000 acre-feet annually. Depletions and farm delivery requirements are summarized by time periods in table 58.

### Supplemental

Inadequately irrigated lands in the subregion will require an additional annual diversion of about 60,000 acre-feet. Most of these lands in need of a supplemental water supply are in the Yakima Valley. The farm delivery would be 50,000 acre-feet and the depletion 40,000 acre-feet annually. Table 59 presents the diversion requirement by major irrigated valley.

Table 58 - Projected Farm Deliveries and Depletions, Subregion 3

| | Presently Irrigated | | Future Irrigation | | Total | |
|---|---|---|---|---|---|---|
| Year | Farm Delivery | Depletion | Farm Delivery | Depletion | Farm Delivery | Depletion |
| | | | (1,000 acre-feet) | | | |
| 1966 | 1,640 | 1,140 | | | 1,640 | 1,140 |
| 1980 | 1,670 | 1,170 | 150 | 110 | 1,820 | 1,280 |
| 2000 | 1,700 | 1,180 | 210 | 160 | 1,910 | 1,340 |
| 2020 | 1,700 | 1,180 | 350 | 270 | 2,050 | 1,450 |

Table 59 - Supplemental Irrigation Diversion Requirements, Subregion 3

| Valley | Water-Short Lands (acres) | Supplemental Requirement (acre-feet) |
|---|---|---|
| Kittitas | 18,000 | 20,000 |
| Yakima | 88,000 1/ | 40,000 |
| Total | 106,000 | 60,000 |

1/ Includes 72,500-acre Roza Division of the Yakima Project and 12,000 acres in the Ahtanum Valley.

Full

Following present trends in irrigation development in Subregion 3, it is anticipated that most future irrigation will be by sprinkler application. Requirements by year 1980 and even to year 2000 reflect the diversified cropping as is presently practiced. For the developments between 2000 and 2020, it is estimated that more intensive use of irrigable land may be practiced with resultant increased crop irrigation water requirements. However, increased efficiency of water application is expected to partially offset this increased requirement. By 2020 it is expected that the newly irrigated lands will require a total of 350,000 acre-feet of water delivered at the farm. The amount depleted by this new irrigation is estimated at 270,000 acre-feet. Table 60 shows estimated unit streamflow depletions and farm deliveries for each major irrigated valley.

Table 60 - Irrigation Requirements and Use, Subregion 3

| Valley | Present-2000 Farm Delivery (AF/ac.) | Present-2000 Depletion (AF/ac.) | 2000 - 2020 Farm Delivery (AF/ac.) | 2000 - 2020 Depletion (AF/ac.) |
|---|---|---|---|---|
| Kittitas | 2.7 | 2.1 | 2.9 | 2.2 |
| Yakima | 3.3 | 2.6 | 3.5 | 2.6 |

## THE POTENTIAL TO MEET THE NEEDS

Irrigation is highly developed in the subregion. However, of the identified land resource suitable for irrigation development, 44 percent is irrigated and 56 percent remains as potentially irrigable.

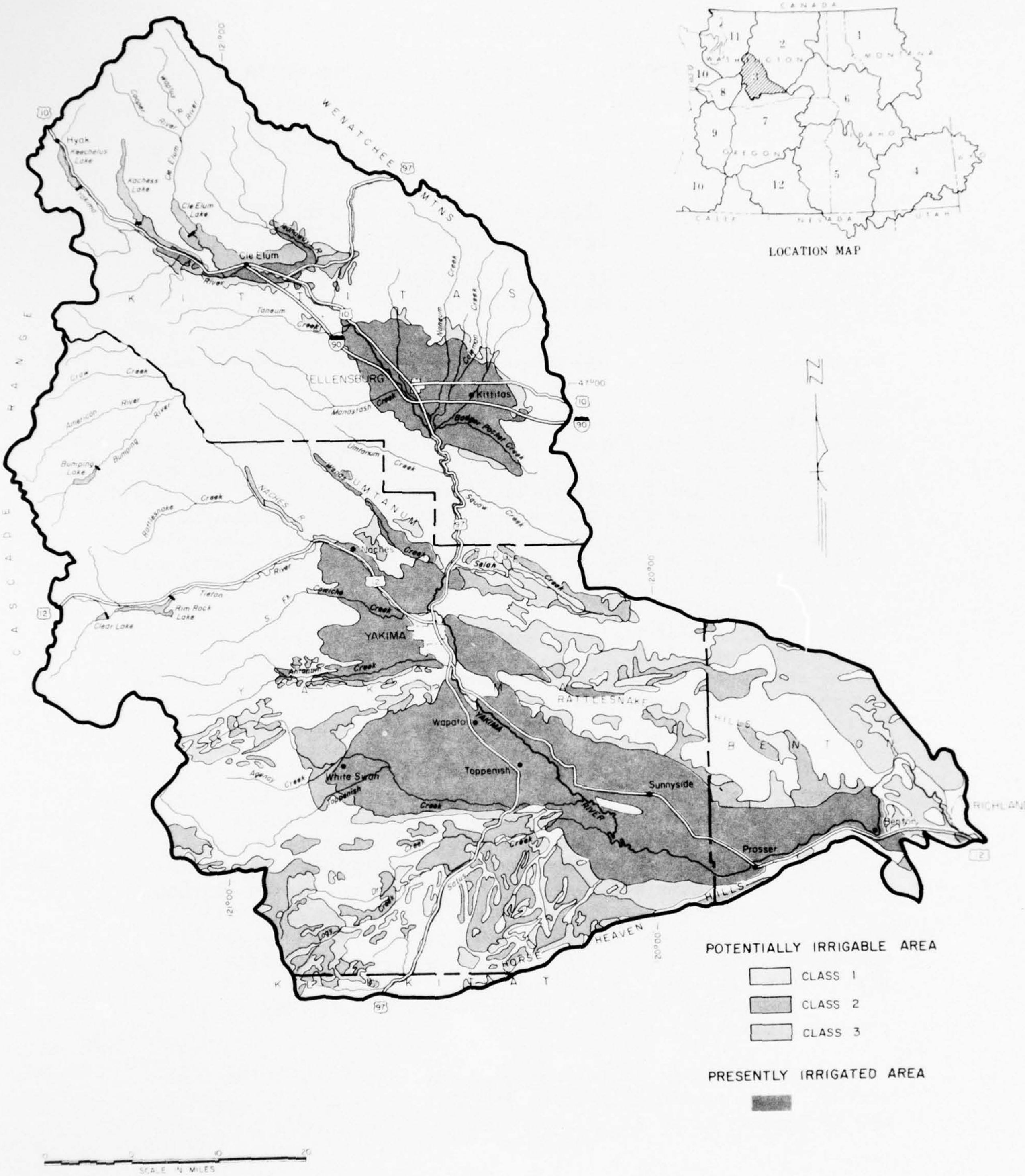
There are about 632,000 acres of potentially irrigable land in the subregion, of which 578,000 are in the Yakima Valley and 54,000 acres in the Kittitas Valley. There is an annual average runoff of 2,350,000 acre-feet of water from the Yakima River and its tributaries. It is projected that 105,000 acres of new irrigation will be needed in the subregion by 2020. In addition, the 106,000 irrigated acres with an inadequate water supply must be provided with a full supply if the subregion's food and fiber needs are to be met.

### Potentially Irrigable Lands

Land classification surveys have identified some 631,900 acres of dry land as potentially irrigable. Included in this figure are both private and public lands in agricultural and non-agricultural uses including some forest lands. Table 61 shows the total number of acres of potentially irrigable lands by land class in the Yakima and Kittitas Valley areas. About 9 percent of the potentially irrigable lands in the subregion are class 1, 42 percent are class 2, and 49 percent are class 3. Their location is shown on figure 20. A brief description of the characteristics of the potentially irrigable lands by valley area is also included.

#### Yakima Valley

Soils have developed on Recent alluvium, loessal, and residual material resulting in variable fertility levels and agricultural values. Soils occurring in the bottom lands are, as a rule, well




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# POTENTIALLY IRRIGABLE AREA

YAKIMA, SUBREGION 3

1968

FIGURE 20

Table 61 - Potentially Irrigable Land, Subregion 3

| Valley | Class 1 | Class 2 | Class 3 | Total |
|---|---|---|---|---|
| | | (acres) | | |
| Yakima | 57,860 | 231,540 | 288,380 | 577,780 |
| Kittitas | 2,200 | 30,870 | 21,080 | 54,150 |
| TOTAL | 60,060 | 262,410 | 309,460 | 631,930 |
| Rounded | 60,100 | 262,400 | 309,400 | 631,900 |
| Percent of total | 9 | 42 | 49 | 100 |

suited for irrigation. There are, however, areas of soils with excessive amounts of surface and subsurface gravel, many of which are suitable only for irrigated pasture. Alluvial textures are commonly silt loams and silty clay loams. The finer textures are in the minority and are sometimes characterized by harmful salts with accompanying hardpans. Such soils would require corrective measures such as leaching and drainage to improve their irrigability.

Crops adapted to the well drained alluvial soils in the bottom lands include alfalfa, corn for grain and silage, sweet corn, mint, truck crops, hops, asparagus, potatoes, and sugar beets. Apples and soft fruits could be grown where air and water drainage is adequate. Irrigated pasture is adapted to a wide range of bottom land conditions including the poorly drained soils.

Upland areas include all potentially irrigable classes. The irrigation of loessal soils which are located on the sloping uplands adjoining the alluvial lands could cause seepage problems in these lower alluvial lands. This potential problem must be recognized in any future plans for irrigation. Predominant textures are silt loams and fine sandy loams. These soils, although situated on more diverse topography than the alluvial soils, produce well when irrigated. Good fruit production is obtainable where air and water drainage is adequate. Other potentially irrigated crops include wheat, alfalfa, sugar beets, corn, mint, timothy and clover mixtures, grapes, asparagus, potatoes, and pasture grasses.

In the Yakima Valley about 10 percent of the potentially irrigable lands were classified as class 1, 40 percent class 2, and 50 percent class 3.

## Kittitas Valley

Soils have developed on Recent alluvium, glacial, and residual materials. Subsoil conditions, slope, and location have controlled their agricultural value.

Soils in the upper part of the Kittitas Valley have developed from glacial outwash material that has been reworked by stream action. Surface soils on the lower benches are shallow and overlie layers of porous sand, gravel, and cobblestone. These soils, when irrigated, should produce suitable yields of alfalfa, timothy and clover mixtures, and pasture. Additional crops such as small grains, sugar beets, corn for silage, and potatoes could be produced on the deeper soils of the high benches. Tree fruits could be grown on lands having favorable air and water drainage.

The lower Kittitas Valley has three major soil groups. The first consists of a sandy loam to clay loam surface soil ranging from 18 to 36 inches in depth and covering a lime hardpan which overlies porous sand and gravel. These soils are located on the higher lying terraces and benches. The second soil group occurs on the more irregular, sloping lands and is more shallow. These soils are characterized by a hardpan layer that overlies semi-consolidated deposits. These two soil groups are located in scattered areas adjacent to the irrigated lands surrounding the city of Ellensburg. The third soil group is the alluvial soils located along the valley streams. These soils have no hardpan layer and are underlain by gravelly subsoils of variable depth. Soils occurring under the latter conditions are the most desirable from an agricultural standpoint, and when irrigated should produce good yields of alfalfa, sugar beets, corn, small grains, timothy and clover, pasture, and potatoes. Tree fruits could be grown on lands having favorable air and water drainage.

Land classification surveys have identified about 4 percent of the potentially irrigable lands as class 1, 57 percent as class 2, and 39 percent as class 3.

## Water Supply

The average annual discharge from the subregion is about 2.3 million acre-feet including ground water discharge. The amount of ground water in storage at depths of 50 to 100 feet below the water table is roughly 13 million acre-feet. Annual natural recharge amounts to about 2 million acre-feet. However, like Subregion 2, there is a large amount of recharge resulting from irrigation in the subregion.

## Potential Developments

Although both valleys will have newly irrigated lands, most of the new land expected to be irrigated by 2020 is in the Yakima Valley. The full development of the water resource within the entire Yakima River subregion is fast becoming a reality, and additional storage or importation of water will have to be considered for much of the potentially irrigable land. In addition to further utilization of Yakima River flows, it is highly likely that Columbia River water will be imported.

### Development by Subarea

Yakima Valley A large block of arable land lies between Yakima and Richland; these lands are just north of lands presently irrigated. Pump lifts would range between 500 to 1,000 feet assuming the source would be the reservoir behind Priest Rapids Dam. About 9,000 acres of this amount lies immediately above the Roza Division and may be served by additional storage. Some areas of low elevation along the Yakima River near Richland could be served by the utilization of irrigation return flows from the Yakima River, either by gravity diversions or low pump lifts.

Other relatively small blocks of land in the Yakima Valley are also expected to come under irrigation in the near future. There are about 7,000 acres adjacent to or scattered throughout the presently irrigated lands. Additional storage will be required and/or ground water will be utilized to serve these areas.

Kittitas Valley About 5,000 additional acres could be irrigated in the Kittitas Valley. The area with the highest potential lies along the Teanaway River north and east of Cle Elum. Yakima River and its tributaries would most likely provide a water supply; additional storage would have to be constructed.

### Private Development

Both private and public interests will play an important role in the development of additional irrigation in this subregion. New private developments will primarily encompass smaller and scattered land areas with both surface and ground water providing the irrigation water supply.

### Federal Development

It is apparent that for any large-scale project-type of development to occur, either new storage will have to be developed or water imported into the subregion, most likely from the Columbia River. Construction of new storage on streams in both the Yakima and Kittitas Valleys to increase the subregion's water supply is a

possible solution being studied by the Federal Government. In addition to the possibility of importing water from the Columbia River, other sources outside the subregion could be available.

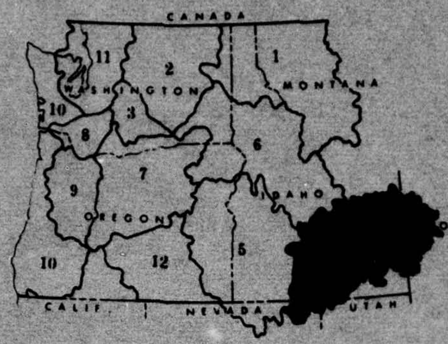
Studies have been made to divert water from the Clear Fork of the Cowlitz River, Cortright Creek, and Summit Creek, all in Subregion 8, into the North Fork of the Tieton River for storage in Rimrock Lake.

The Wapato Indian Project located west of White Swan could irrigate additional lands if water were available. About 14,000 acres could be developed under the proposed plan.

Investigations at the Federal level have been made on various alternatives to irrigate additional lands in the Yakima Indian Reservation. These studies include the Ahtanum Creek, Wapato-Satus Unit, Toppenish-Simcoe Project, and the Mabton Project. The plan for the Toppenish-Simcoe Project would provide storage of 64,600 acre-feet, which would irrigate about 14,000 acres. The plan for the Mabton Project would provide for a dam and reservoir storing about 85,000 acre-feet.

Diversion of Klickitat River flows into the Wapato and Toppenish Creeks would insure a full water supply for these proposed new land developments.

Potentially irrigable lands are located in the U. S. Atomic Energy zone and the Yakima Firing Center. However, because of present policies governing use of these lands, they are not considered likely to be irrigated by 2020.



LOCATION MAP

# SUBREGION 4

# SUBREGION 4

## UPPER SNAKE

### THE SETTING

The Upper Snake Subregion covers the entire upper Snake River drainage basin, an area of nearly 36,000 square miles. Eighty percent is in southeastern Idaho, 15 percent in Wyoming, 4 percent in Nevada, and 1 percent in Utah.

The broad Snake River Plateau, the subregion's most prominent landform, is surrounded by mountain ranges on the north, east, and south.

The Snake River flows from east to west, skirting the broad Snake River Plain on the south; this broad, fertile plain extends nearly the entire breadth of the subregion. From its headwaters in Yellowstone National Park, it flows more than 500 miles before leaving the subregion at King Hill, Idaho. Major tributaries include Buffalo Fork, Gros Ventre, Hoback, Greys, Salt, Teton, Henrys Fork, Blackfoot, Portneuf, and Big Wood Rivers. See figure 21.

The subregion contains one of the largest and most productive ground water reservoirs in the world--the Snake Plain aquifer. This aquifer is made up of the successive lava flows underlying the Snake River Plain; it ultimately discharges as springs into the Snake River at the lower end of the subregion. The aquifer is recharged in part by "lost rivers" which sink into the ground before they reach the Snake River.

On much of the Snake River Plain total annual precipitation is less than 10 inches. Summers are hot and dry and the winters are generally cool and moist. Average annual temperatures on the plain range from 40° F. to 50° F.; extremes of -40° F. and 110° F. have been recorded. The growing season ranges from a high of 150 days along the Snake River at the lower (western) end of the Snake River Plain to 110 days at the upper end and less in the higher mountain valleys.

More than 70 percent of the subregion area is in public ownership. Rangeland covers most of it, although a significant acreage of forest land is located in the higher elevations. Of the remaining acreage in private ownership, about one-half is cropped and much of the remainder is rangeland.

As in most of the Columbia-North Pacific Region, early settlement of the Upper Snake Subregion was stimulated by the construction of railroads. They provided access to markets on the Pacific Coast and in the middle west.

Transcontinental routes of railroads and highways use the Snake River Valley as a gateway to crossing the Rocky Mountains. State, county, and local roads provide access to all portions of the subregion. Several cities are served by commercial airlines.

Slightly more than 300,000 people live in the subregion; the population density is less than 8 people per square mile. The several large towns located near the Snake River include Idaho Falls, Pocatello, and Twin Falls. Many smaller communities have developed, primarily in the large agricultural areas.

Agriculture has long been important in this subregion. Farming, food processing, and chemical products provide the major concentrations of employment.

Irrigation began over 100 years ago in the subregion. Railroad construction in the 1870's stimulated irrigation development. In this period large numbers of farmers moved from the Great Salt Lake Valley to settle in southeastern Idaho. Developing cooperative irrigation systems based on their successful experience in Utah, they were soon irrigating lands in the Henrys Fork and Upper Snake River valleys.

The Carey Act of 1894 made Federal lands available to the states in an attempt to encourage the settlement of the desert lands. Idaho has, within the confines of the state, more than half of the total acreage patented under the act. Thus lands patented in Idaho include nearly a million acres under the Desert Land Act, and more than 600,000 acres under the Carey Act. Most of these lands are located in the Upper Snake Subregion.

The Snake River and its tributaries are heavily used for irrigation; reservoirs principally serving irrigation have been constructed on most of the large streams in the subregion.

Minidoka Dam was one of the first projects built under the Reclamation Act of 1902; it was the first of many Federally sponsored storage and distribution projects which have successfully expanded Upper Snake irrigation. Within 15 years after the construction of Minidoka Dam, the nearby sagebrush desert had been converted into more than 2,000 irrigated farms supporting a local population of 17,000.

Major storage has been developed by the Federal Government at Jackson Lake, American Falls, and most recently at Palisades

Reservoir. These three reservoirs alone store well over 3.5 million acre-feet of water for irrigation and other uses. These and other smaller reservoirs of the Minidoka Project serve canal companies and irrigation districts the length of the Upper Snake Subregion, providing all or part of the water supply for more than a million acres in thousands of farms. Smaller Federally financed projects have been constructed to serve other subregion lands.

*Jackson Lake, near the headwaters of the Snake River, is a major component of the 6 million acre-feet of total storage capacity in the Upper Snake Subregion. (Bureau of Reclamation)*

From an estimated 1.5 million acres irrigated at the end of World War II, irrigation has increased by a million acres to the current total of nearly 2.5 million acres, an average of 40,000 acres of new irrigation each year.

Much of the new irrigation in recent years has been based on ground water pumping. Since 1955 more than 600,000 acres have been developed by both private and public interests using ground water pumping. The North Side Pumping Division of the Minidoka Project irrigates nearly 70,000 acres near Burley, Idaho, from deep wells. Developed in the mid-1950's, this division helped demonstrate the

feasibility of large-scale ground water pumping for irrigation in this subregion. More recently, extensive privately financed ground water pumping projects have been built both north and south of the Snake River.

To help in presentation, Subregion 4 has been divided into seven subareas. Figure 22 shows the breakdown.

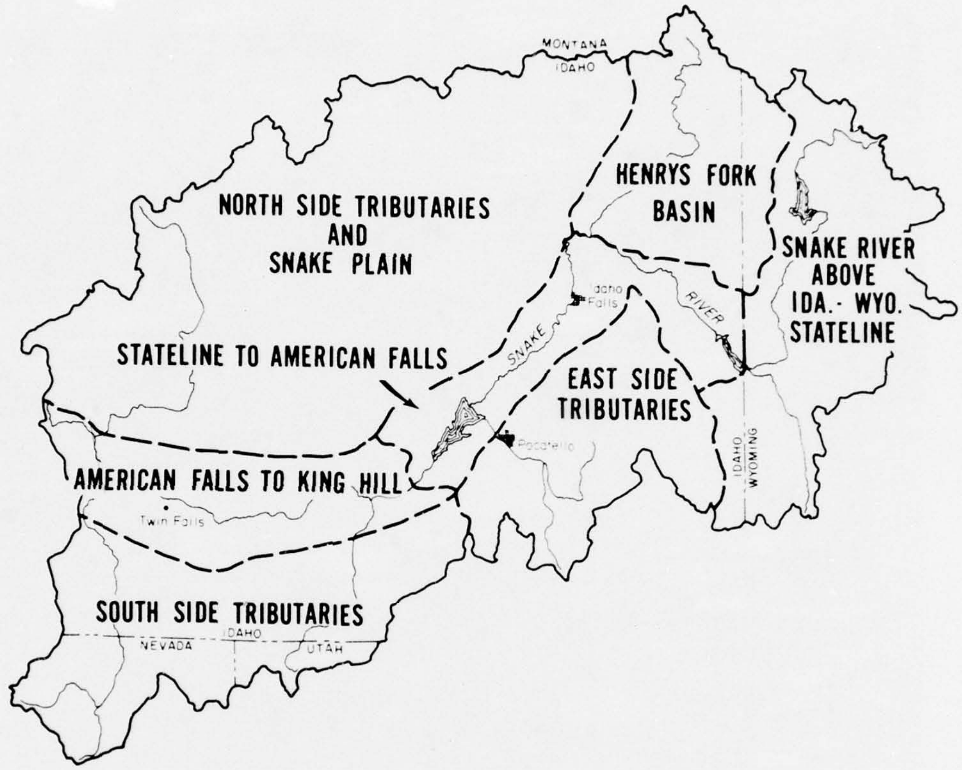



FIGURE 22. Subareas in Subregion 4, Upper Snake.

## PRESENT STATUS

Irrigation has been the major user of water in the Upper Snake Subregion since first settlement. Without irrigation, much of the subregion's land would support at most only limited livestock grazing. Irrigated agriculture has been the most important economic activity in the subregion by a wide margin; there is no other economic activity to compete with it. Virtually the entire population of the subregion is concentrated in the irrigated areas.

An area of 2,485,000 acres was irrigated in 1966, according to studies made by the Soil Conservation Service and the Bureau of Reclamation. Included is a small acreage devoted to irrigated forest nurseries and seed orchards, recreation sites, and tracts used for wildlife and other nonagricultural purposes. The irrigated acreages by source and adequacy of supply and method of irrigation are shown in table 62.

Table 62 - Irrigated Area, 1966, Subregion 4

| State | Surface Water | | Ground Water | | Method of Irri. | | Total |
|---|---|---|---|---|---|---|---|
| | Adequate Supply | Inadeq. Supply | Adeq. Supply | Inadeq. Supply | Sprinkler | Gravity | Area |
| | | | (acres) | | | | |
| Idaho | 1,409,000 | 244,000 | 522,000 | 152,000 | 466,000 | 1,861,000 | 2,327,000 |
| Wyoming | 37,000 | 101,000 | - | - | 13,000 | 125,000 | 138,000 |
| Nevada | 6,000 | 7,000 | - | - | - | 13,000 | 13,000 |
| Utah | 1,000 | 6,000 | - | - | - | 7,000 | 7,000 |
| Total | 1,453,000 | 358,000 | 522,000 | 152,000 | 479,000 | 2,006,000 | 2,485,000 |

## Characteristics of Irrigated Areas

As shown on figure 21, irrigation is extensive; eight of the subregion's counties each contain over 100,000 acres of irrigation. Most of the subregion's irrigated area is included in the two large blocks of irrigation on the Snake River Plain. The upper Snake Plain irrigated area extends from the Henrys Fork basin downstream to American Falls Reservoir; the lower area extends from Lake Walcott downstream to the western limit of the subregion. Diversified cropping patterns, including the production of high-value rowcrops, are well established on these lands.

The smaller irrigated areas scattered throughout the subregion are generally used to produce forage crops for livestock grazed on the subregion's extensive rangelands. These smaller areas, including the lands in Wyoming, Nevada, and Utah, are often located in the high mountain valleys which have shorter growing seasons than the Snake River Plain.

Nearly 75 percent of the subregion's irrigated area is served from surface water; it is extensively used because of its accessibility and the lower costs involved.

The remaining slightly more than 25 percent of the irrigated area is irrigated from ground water. The rapid growth of ground water developments in recent years is largely the result of the

overappropriation of the subregion's surface waters in dry years and the availability of abundant ground water in the Snake Plain aquifer.

A total of some 1.9 million irrigated acres was enumerated within the economic study area in 1964 by the U. S. Census of Agriculture. The economic study area includes the following counties: Bannock, Bingham, Blaine, Bonneville, Butte, Camas, Caribou, Cassia, Clark, Fremont, Gooding, Jefferson, Jerome, Lincoln, Madison, Minidoka, Power, Teton and Twin Falls in Idaho, and Teton in Wyoming. In 1964, the economic study area contained 14,100 farms, of which 12,600 or 90 percent, were classified as irrigated. Although the subregion has a wide variety of farm types, the typical farm is a diversified operation containing a combination of field crop and livestock enterprises.

*Irrigated lands produce nearly two-thirds of the feed required by the Upper Snake livestock industry. (Bureau of Reclamation)*

The 12,600 irrigated farms contained a total of 5.5 million acres, of which about 1.9 million acres were actually irrigated. The average farm size was 440 acres, with 150 acres irrigated per farm. Seventy percent of the irrigated land was used to grow

forage and grains; 24 percent used for major field crops, including potatoes and sugar beets; and the remaining 6 percent was planted to vegetables and other crops. Figure 23 shows the acreages irrigated for the production of harvested cropland and pasture in Subregion 4 for 1964.

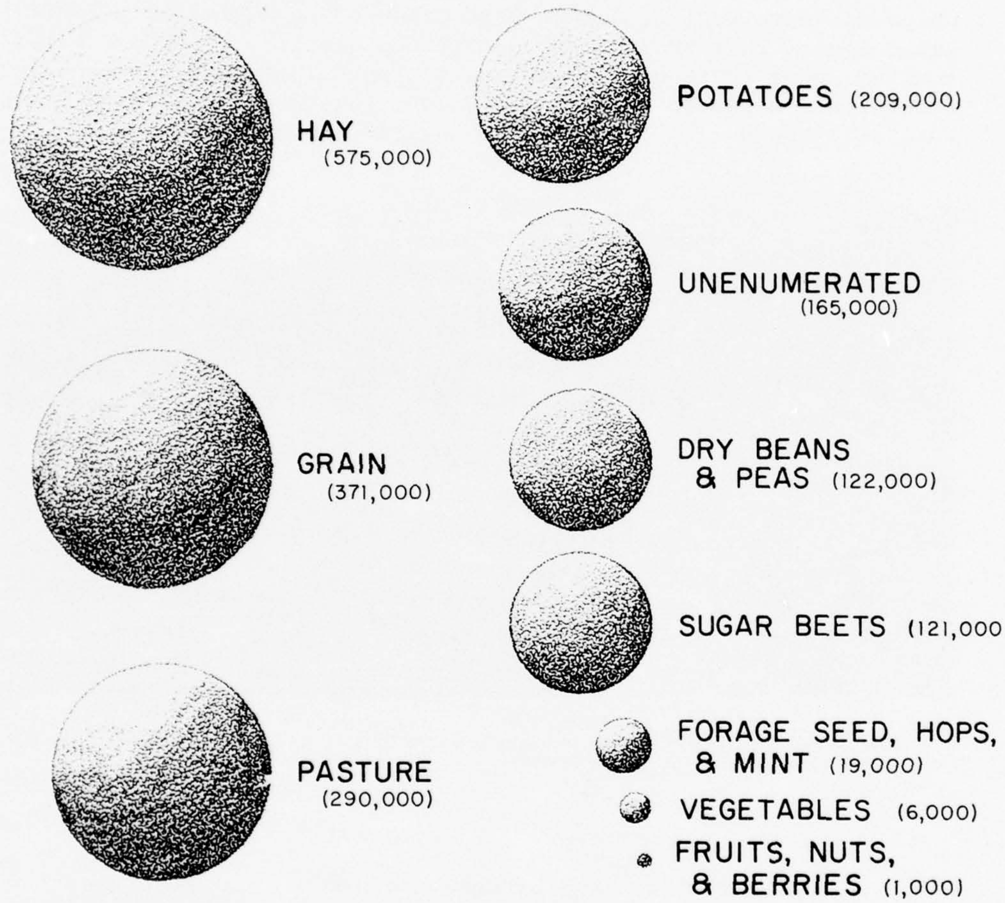



FIGURE 23. Acreages of Irrigated Cropland Harvested and Pasture, 1964, Subregion 4.

## Production of Irrigated Crops

In 1964 the subregion produced over 85 percent of Idaho's total potato production and contributed largely to Idaho's ranking as the leading potato-producing state in the Nation. Subregion 4 produced nearly 60 percent of the potatoes grown in the Columbia-North

Pacific Region in 1964. Virtually all the potatoes produced in the subregion are grown under irrigation. Several large potato-processing plants are located within the subregion; these plants market frozen, dried, and other varieties of processed potatoes. In addition, the subregion's many potato warehouses ship fresh potatoes to all parts of the United States.

Nearly 40 percent of the sugar beets grown in 1964 in the Columbia-North Pacific Region were produced on Subregion 4 irrigated land. This production contributes heavily to Idaho's third ranking among sugar beet producing states. Three sugar-processing factories are located in the subregion; the one located at Lincoln, east of Idaho Falls, is among the largest in the world.

*This Upper Snake sugar factory depends on a stable supply of high-quality sugar beets from the surrounding irrigated farms. (Bureau of Reclamation)*

Irrigation has also brought the production and processing of specialty crops such as sweet corn and green peas into prominence. Twin Falls County, Idaho, on the western edge of the subregion, leads the Nation in the production of garden bean seed and ranks high nationally in the production of dry field beans. In 1964, the subregion produced nearly 30 percent of the dry beans and peas grown in the Columbia-North Pacific Region.

Production of irrigated crops is compared with total production by crop category in table 63. Nearly 55 percent of small grain production is grown under irrigation while nearly 90 percent of hay production is irrigated. Production from the remaining crop

categories is virtually all irrigated. Yields of selected major crops are presented in table 64. Due to bad weather conditions in 1964, these crop yields are less than what are normally realized.

Table 63 - Summary of Crop Production, 1964, Subregion 4

| Crop Category | Units | Production Total (1000's) | Production Irrigation (1000's) | Percent Irrigated |
|---|---|---|---|---|
| Small grains | tons | 927 | 507 | 54.7 |
| All hay | tons | 2,035 | 1,829 | 89.9 |
| Dry beans and peas | cwt. | 1,929 | 1,929 | 100.0 |
| Sugar beets | tons | 1,740 | 1,740 | 100.0 |
| Potatoes | cwt. | 32,314 | 32,314 | 100.0 |
| Vegetables | cwt. | 594 | 594 | 100.0 |
| Fruits, nuts, and berries | tons | 2 | 2 | 100.0 |
| Forage seed, hops, and mint | lbs. | 4,971 | 4,954 | 99.7 |

Source: Derived from Census of Agriculture and Agricultural Statistics.

Table 64 - Yields for Selected Major Irrigated Crops, 1964, Subregion 4

| Crops | Units | Yield Per Acre |
|---|---|---|
| Grains and forage | | |
| Wheat | tons | 1.44 |
| Barley | tons | 1.27 |
| Alfalfa hay | tons | 3.3 |
| Field Crops | | |
| Potatoes | cwt. | 155 |
| Dry beans | cwt. | 15.0 |
| Sugar beets | tons | 14.4 |

Irrigated lands support much of the subregion's important livestock industry. Animals grazed on nonirrigated public and private rangelands are wintered and fattened for market on feed grown on irrigated land. In 1964, irrigated land furnished an estimated 63 percent of the total feed requirement of the livestock industry.

## Value of Production

The total value of production from irrigated land was estimated to be $206 million in 1964. The estimated value of crop production totaled $132 million; field crops, including potatoes, sugar beets, and dry beans, were the principal contributors. Feed crops were not included in this total but are reflected in the $74 million estimated value of livestock and livestock products.

## Economic and Social Impacts

Crops grown on irrigated lands and industries allied with this production directly or indirectly support most of the people living in the subregion. This dependence of the total economy on irrigation has been enhanced by the rapid growth in recent years of a large food-processing industry which relies on an uninterrupted supply of high-quality production from irrigated farms. Other industries also depend on irrigated agriculture; for example, much of the output of the thriving phosphate industry is in the form of fertilizer for the irrigated lands.

To identify the economic impact of irrigation in Subregion 4, the conclusions of a study of the Columbia Basin Project in Eastern Washington were applied. The economy of the Columbia Basin Project area is similar to the economy in Subregion 4. The estimated gross economic impact of irrigated agriculture is presented in table 65.

Table 65 - Gross Value of Agricultural Products and Services Associated with Irrigation Use in 1964, Subregion 4

| Industry | Gross Value ($1,000,000) |
|---|---|
| Irrigated agriculture | 206 |
| Processing | 175 |
| Trades and services | 349 |
| Total | 730 |

## Use of Water

The natural flow of the Snake River above Milner Dam (the last major Snake River diversion point in this subregion) is fully appropriated for irrigation during years of below-normal runoff. If it were not for the subregion's many storage reservoirs, much of

*Many of the subregion's communities (such as Shelley, Idaho, above) are directly supported by irrigation agriculture and its associated industries. (Bureau of Reclamation)*

the irrigated land would suffer severe late-season water shortages every year; these reservoirs supply one-fourth of the water used for irrigation annually.

Most of the ground water used in the subregion is pumped from the Snake Plain aquifer. In most areas, ground water resources are ample, but in places local aquifers have been depleted.

More than 13.5 million acre-feet are diverted for irrigation of 2.5 million acres as shown in table 66. Diversions above Milner Dam total nearly 10 million acre-feet annually, leaving only 1.1 million acre-feet of average annual runoff below Milner. Between Milner Dam and the downstream boundary of the subregion, the Snake River receives large ground water inflows and some surface inflows. The total amount of water flowing out of the subregion averages 6.2 million acre-feet annually.

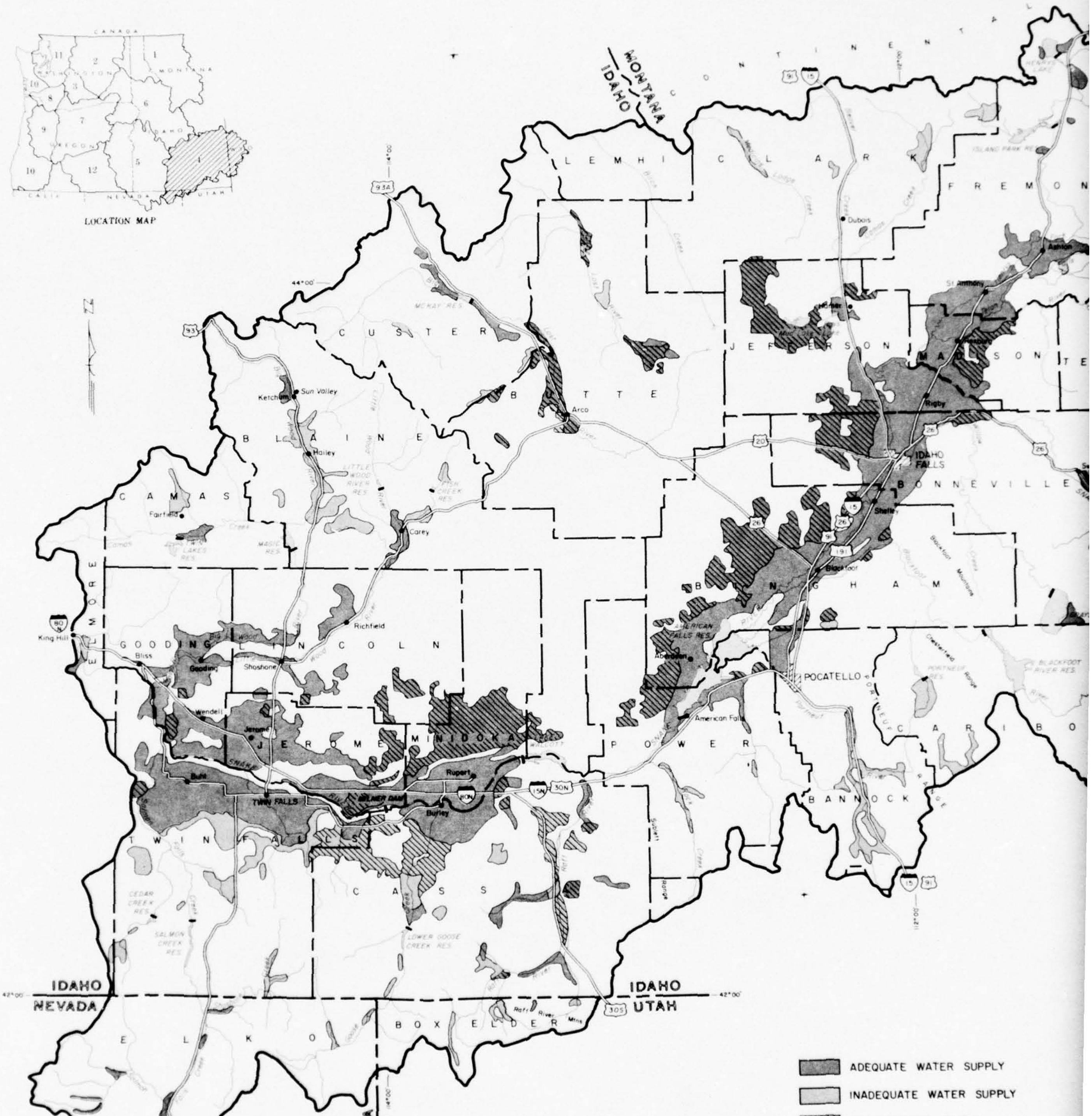
Because water supply and water use conditions in the subregion are so varied, irrigation diversions are separated by subarea.

(1) Subarea above Idaho-Wyoming stateline. Water from the Snake River and tributaries entering it in Wyoming is used

Table 66 - Use of Water for Irrigation, 1966 level, Subregion 4

| AREA | SURFACE WATER: Lands with Adequate Supply: Area (acres) | Natural Flow (ac-ft) | Storage Use (ac-ft) | Lands with Inadequate Supply: Area (acres) | Natural Flow (ac-ft) | Storage Use (ac-ft) | Shortage (ac-ft) | GROUND WATER: Area (acres) | Diversion (ac-ft) | TOTAL AREA IRRIGATED (acres) | TOTAL DIVERSIONS (ac-ft) | RETURN FLOW (ac-ft) | DEPLETION (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Snake River above *Idaho-Wyo. stateline* | 37,000 | 200,000 | 0 | 113,200 | 560,000 | 0 | 180,000 | 0 | 0 | 150,200 | 760,000 | 580,000 | 180,000 |
| Henrys Fork basin | 138,000 | 942,000 | 154,000 | 48,000 | 248,000 | 0 | 60,000 | 28,900 | 96,000 | 215,100 | 1,440,000 | 1,112,000 | 328,000 |
| Snake River--stateline to American Falls Main stem | 417,500 | 2,704,000 | 502,000 | 0 | 0 | 0 | 0 | 210,600 | 695,000 | 627,800 | 3,901,000 | 2,551,000 | 1,350,000 |
| East side tributaries | 68,000 | 426,000 | 40,000 | 70,800 | 420,000 | 127,000 | 90,000 | 0 | 0 | 138,400 | 1,013,000 | 713,000 | 300,000 |
| Snake River--American Falls to King Hill Main stem | 564,500 | 1,857,000 | 1,623,000 | 0 | 0 | 0 | 0 | 136,500 | 450,800 | 700,800 | 3,930,800 | 2,529,800 | 1,401,000 |
| North side tributaries & Snake Plain | 155,000 | 384,000 | 436,000 | 69,000 | 280,000 | 95,000 | 150,000 | 141,000 | 482,000 | 365,400 | 1,677,000 | 891,000 | 786,000 |
| South side tributaries | 73,000 | 328,000 | 0 | 57,000 | 64,000 | 55,000 | 124,000 | 157,000 1/ | 372,200 | 287,300 | 819,200 | 244,200 | 575,000 |
| SUBREGION TOTALS | 1,453,000 | 6,841,000 | 2,755,000 | 358,000 | 1,572,000 | 277,000 | 604,000 | 674,000 | 2,096,000 | 2,485,000 | 13,541,000 | 8,621,000 | 4,920,000 |

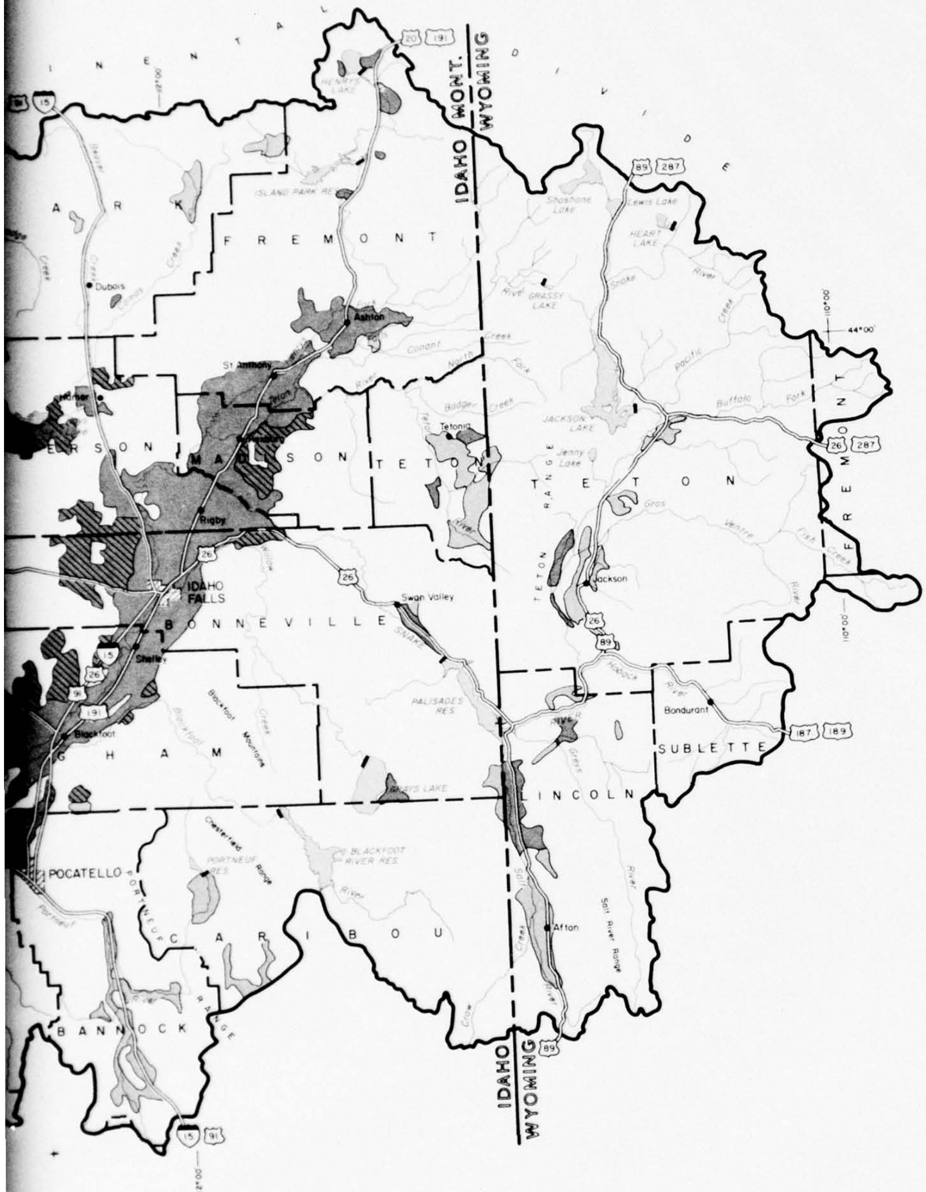
1/ Includes 152,000 acres with an inadequate or undependable supply; estimated shortage is 100,000 acre-feet on this acreage.



LOCATION MAP
CANADA
MONTANA
WASHINGTON
OREGON
IDAHO
NEVADA
UTAH
MONTANA
IDAHO
CONTINENTAL
LEMHI
CLARK
FREMONT
CUSTER
BUTTE
JEFFERSON
MADISON
BLAINE
CAMAS
BONNEVILLE
BINGHAM
ELMORE
GOODING
LINCOLN
JEROME
MINIDOKA
POWER
BANNOCK
CARIBOU
TWIN FALLS
CASSIA
ELKO
BOX ELDER
IDAHO
NEVADA
IDAHO
UTAH
NEVADA
UTAH
Sun Valley
Ketchum
Hailey
Carey
Fairfield
Arco
Dubois
St Anthony
Ashton
Rigby
IDAHO FALLS
Shelley
Blackfoot
POCATELLO
American Falls
Aberdeen
AMERICAN FALLS RES
Richfield
Shoshone
King Hill
Bliss
Gooding
Wendell
Jerome
Buhl
TWIN FALLS
MILNER DAM
Rupert
Burley
MCKAY RES
LITTLE WOOD RIVER RES
MAGIC RES
ISLAND PARK RES
CEDAR CREEK RES
SALMON CREEK RES
LOWER GOOSE CREEK RES
BLACKFOOT RIVER RES
SCALE IN MILES
ADEQUATE WATER SUPPLY
INADEQUATE WATER SUPPLY
GROUNDWATER SUPPLY

1

2




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# IRRIGATED AREA

UPPER SNAKE, SUBREGION 4

1968

FIGURE 21

mainly to irrigate hay and pastureland; annual diversions in this subarea total 760,000 acre-feet (see table 66). Most of the irrigated lands are in the Jackson Hole and in the Salt River drainage, which also contains some Idaho lands. Along the tributaries without reservoirs, lands are heavily irrigated during the early season when flows are high. Because runoff is usually inadequate later in the irrigation season, most of these lands suffer some water shortages.

(2) Henrys Fork basin. Natural streamflow supplies most of the 1,440,000 acre-feet of annual irrigation diversions in the Henrys Fork basin. Diversion amounts differ widely within the basin, ranging from less than 3 acre-feet per acre to well over 10 acre-feet per acre. Though most of the subarea's lands are irrigated by conventional methods, the larger diversions are made on the subirrigated lands in this area. High losses from these diversions contribute to usable return flows downstream.

(3) Snake River--stateline to American Falls. Lands irrigated from the Snake River in this subarea usually receive adequate water supplies because they have storage to meet late season needs. West of the river on the Snake Plain, recent development has been largely by ground water pumping. Annual diversions to lands along the main stem in this subarea total nearly 4 million acre-feet, and include large quantities of return flow from upstream irrigation in the Henrys Fork basin and irrigation within this subarea.

(4) East side tributaries. Lands irrigated from these tributary streams usually suffer late-season shortages. During the spring runoff period, diversions are quite high; but after the peak flows have passed, supplies are inadequate. Though some storage is available on the Blackfoot and Portneuf Rivers, it is inadequate to supply all the needs of the irrigated lands in those river basins; storage contributes only 16 percent of the water used for irrigation along the tributaries in this subarea.

(5) Snake River--American Falls to King Hill. This subarea, known locally as the Magic Valley, contains 700,800 irrigated acres, about half the total irrigated area below American Falls. Since irrigators in this area have good natural-flow rights and own much of the Snake River storage, their lands are well supplied. Much of the ground water use in this subarea is north of the Snake River in the North Side Pumping Division of the Minidoka Project.

(6) North side subarea. This subarea includes the Big Wood River drainage and the drainages of all the "lost rivers." Runoff from these areas enters the Snake Plain aquifer before reaching the Snake River. Lands in the headwater areas of the tributary streams are heavily irrigated in the spring, but on the many tributaries lacking storage, the lands usually suffer water shortages late in the growing season. Return flows from these upper valleys augment both surface and ground water supplies for the lower areas through much of the season; in the absence of reservoirs, this water retention is beneficial. The use of ground water at the lower ends of these stream basins and on the Snake Plain itself is becoming extensive.

(7) South side tributaries. The subarea south of the main river valley contains the Raft River, Goose Creek, and Salmon Falls Creek drainages. Irrigation water shortages in this subarea are the most severe in Subregion 4. Natural streamflows are limited, and only modest amounts of storage are available. In one watershed, the surface water supply varies so greatly from year to year that the area to be irrigated is adjusted each year in accordance with runoff forecasts.

A large acreage in this subarea has been irrigated by ground water pumping in recent years. However, the heavy ground water pumping has caused declining water tables in many places. As a result, nearly all the lands irrigated from ground water in this subarea are inadequately supplied.

Return flows from irrigation diversions made within the subregion are estimated to be approximately 8.6 million acre-feet annually and are presented for each of the above subareas in table 66.

The portion of the irrigation diversions returning to the stream channels as surface water above Milner Dam is generally rediverted for irrigation. Flows which return to the Snake River below Minidoka Dam (which forms Lake Walcott, the last significant main stem storage in the subregion) are usable within this subregion only during the irrigation season. Above the dam, flows returning during the nonirrigation season are stored whenever space is available.

Most of the irrigation return flows, however, sink to the Snake Plain aquifer which discharges large quantities of water to the Snake River in two principal locations:

(1) Into American Falls Reservoir and the river for some distance upstream. This return flow is generally reusable.

(2) In the reach from Milner Dam to the downstream edge of the subregion, particularly in the Thousand Springs area. Because this reach is below all major irrigation diversions in the subregion, most of the ground water discharge is not reusable within the subregion. It does, however, contribute most of the Snake River's flow as it enters Subregion 5.

The depletion of surface and ground water in the subregion because of irrigation totals approximately 4.9 million acre-feet annually. Approximately 85 percent of this total is used beneficially in crop production; the remainder is nonbeneficially used within and adjacent to the irrigated areas.

## Adequacy of Supply

Water shortages are shown by area in table 66 and the location of the 510,000 acres with inadequate water supplies is shown on figure 21. Shortages average about 700,000 acre-feet annually.

Enough reservoir storage space is available to augment natural flows and to supply the full requirements of lands diverting from the Snake River under most runoff conditions. A recurrence of extremely dry conditions, such as occurred in 1934, 1935, and 1961, however, would cause shortages throughout the subregion.

The water supplies on the smaller tributary streams contrast sharply with the supply on the Snake River because there are few major reservoirs on the tributaries. Shortages range from minor amounts (10 to 15 percent) for lands along the Little Lost River to as much as 60 percent on lands diverting from other north side tributaries.

Lands receiving either all or part of their water supply from ground water are generally adequately supplied. However, about 152,000 acres south of the Snake River below American Falls Dam experience shortages of about 20 percent. Because of declining ground water levels, the State of Idaho has declared ground water conditions critical in parts of this area and has restricted further well development.

## Application of Water

Most of the lands served directly from the Snake River are irrigated by gravity methods including border strips, corrugations, and wild flooding. These methods are also used on most of the lands

*A youth primes a siphon tube to irrigate a field of high-value Idaho potatoes. The ditch is concrete-lined to conserve water. (Bureau of Reclamation)*

along the tributaries, particularly in the mountain valleys in Wyoming and along the upper reaches of the Snake River's north side tributaries. The subregion also has a few subirrigated areas; under subirrigation, local water tables are maintained near the plant roots by gravity diversions. This method is used in some areas with highly permeable soils.

Sprinkler irrigation has steadily gained in importance, particularly in the new ground water developments both on the Snake River Plain and at the lower ends of the tributary drainages. From 1954 to 1966, the Idaho acreage under sprinkler irrigation increased from less than 100,000 to more than half a million. Factors contributing to the trend toward sprinkler irrigation include increased efficiency through sprinkler application, scarcity of unappropriated surface water, development of new lands with topography unsuitable for gravity irrigation, and lower labor costs.

## Quality of Water

Throughout the Upper Snake Subregion, surface and ground water have been satisfactorily used for irrigation for many years with few harmful effects.

Surface flows in the headwaters of the Snake River and its tributaries are of excellent quality. As the water moves downstream, both dissolved solids and sodium content increase considerably. On some tributaries, dissolved solids increase sevenfold. The increase is partly from natural processes and partly from irrigation and other uses. In the Snake River itself, solids increase as the river flows through the subregion until the river is diluted by the large spring inflows from the Snake Plain aquifer. The Snake River increases in total solids from approximately 160 parts per million (ppm) as it enters the Snake Plain to more than 400 ppm just upstream from the springs at the lower end of the subregion. The spring inflow then dilutes total solids to approximately 330 ppm.

# FUTURE NEEDS

Projections indicate 725,000 acres of new irrigation development will be needed in Subregion 4 by 2020 to meet food and fiber requirements. This represents 12 percent of the total projected regional need and a 29 percent increase over the presently irrigated acreage in Subregion 4. Though this is a large amount of new irrigation, it is much less than the 84 percent increase projected for the entire Columbia-North Pacific Region. If Subregion 4 is to meet its share of needed food and fiber, the water-short lands must also be provided with a full water supply.

## Land

The projections of irrigated acreage needs are based primarily on satisfying projected food and fiber requirements and crop yields. Additional considerations include availability of land and water, anticipated state, Federal, and private developments, and political and social factors affecting irrigation expansion.

Satisfaction of future needs will require an expansion in irrigated acreage from 2,485,000 acres in 1966 to 2,920,000 by 1980, to 3,030,000 acres by year 2000, and 3,210,000 acres by 2020. These projected needs are based on projected productive irrigated cropland and pasture with adjustments to include other irrigated lands not used for crops and pasture. The development of these figures is presented in table 67.

Table 67 - Irrigated Area Needs by 1980, 2000, and 2020, Subregion 4

| Item | Irrigated Acreage 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|
| Harvested cropland and pasture 1/ | 2,375 | 2,458 | 2,595 |
| Other 2/ | 545 | 572 | 615 |
| Total irrigated area | 2,920 | 3,030 | 3,210 |

1/ From table 68.
2/ Includes irrigated forest, range, rights-of-way, ditches, roadways, farmsteads, urban, and idle irrigated lands not used in the production of projected crop requirements. Includes irrigated area outside economic subregion but within hydrologic boundary of: 1980, 126,000 acres; 2000, 138,000 acres; 2020, 157,000 acres.

Productive irrigated lands consisting of irrigated cropland harvested and pasture are identified by crop categories in table 68. Livestock feed crops are expected to continue as the largest users of irrigated land. Potatoes and sugar beets also will continue as the major cash crops.

Table 68 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020, Subregion 4

| Crop Category | Acreage Needs 1/ 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|
| Small grains | 573 | 546 | 498 |
| All hay | 688 | 717 | 792 |
| Dry beans and peas | 106 | 108 | 110 |
| Sugar beets | 148 | 199 | 242 |
| Potatoes | 294 | 305 | 327 |
| Vegetables | 7 | 6 | 6 |
| Fruits, nuts, and berries | 1 | 1 | - |
| Forage seed, hops, and mint | 23 | 22 | 21 |
| Pasture | 347 | 359 | 394 |
| Unenumerated | 188 | 195 | 205 |
| Total | 2,375 | 2,458 | 2,595 |

1/ Includes only needs within economic subregion.

## Production and Yield

A summary of crop production from irrigated land is presented in table 69. Projected crop yields are presented in index form by crop category in figure 24. These indexes are related to 1964 yields referenced at a base of 100. Attainment of higher rates of average yield increase would result in a lesser need for irrigation expansion. However, attainment of yield rates less than the projections would require a greater expansion of irrigation development.

Table 69 - Crop Production from Projected Irrigated Acreage for 1980, 2000, and 2020, Subregion 4

| Crop Category | Units | Production 1980 | 2000 | 2020 |
|---|---|---|---|---|
| | | (1000's) | | |
| Small grain | tons | 1,176 | 1,376 | 1,543 |
| Hay | tons | 2,767 | 3,486 | 4,522 |
| Dry beans and peas | cwt. | 2,321 | 2,912 | 3,560 |
| Sugar beets | tons | 2,817 | 4,110 | 5,315 |
| Potatoes | cwt. | 64,187 | 80,271 | 97,595 |
| Vegetables | cwt. | 1,141 | 1,181 | 1,544 |
| Fruits, nuts, and berries | tons | 3 | 5 | - |
| Forage seed, hops, and mint | lbs. | 6,182 | 7,488 | 9,071 |

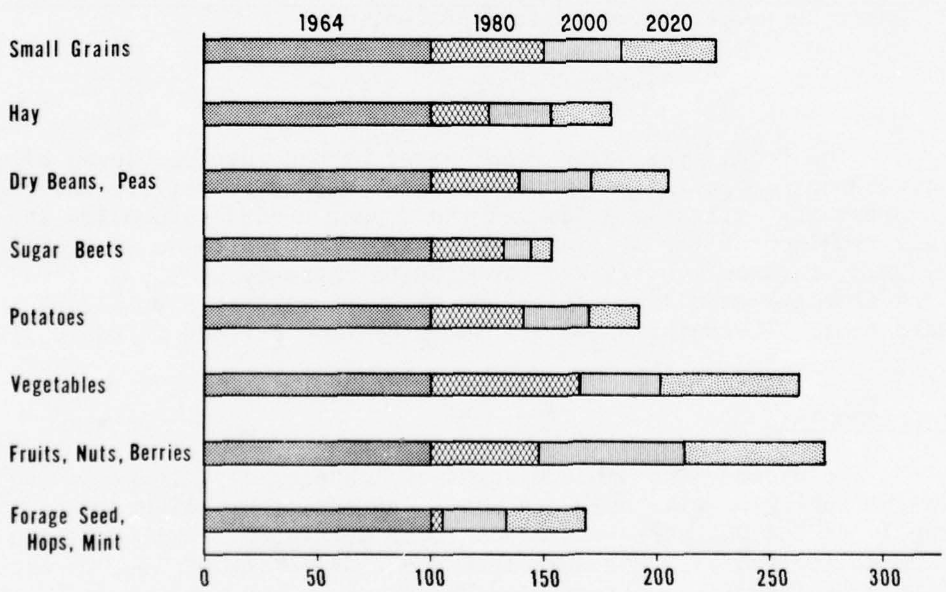



FIGURE 24. Projected Crop Yields in 1980, 2000, and 2020 for Selected Crops (1964 as Base Year Equals 100), Subregion 4.

## Value of Production

Projected values of irrigated crop production are presented in table 70. These values are inclusive of irrigated crops fed to livestock with the exception of irrigated pasture. The values are based on projected production to meet food and fiber needs and the same price structure used by Office of Business Economics and the Economic Research Service (OBERS) in the regional projections.

Table 70 - Value of Projected Irrigated Crop Production, Subregion 4

| Crop Category | Value of Production 1/ 1980 | 2000 ($1,000) | 2020 |
|---|---|---|---|
| Small grains | 62,200 | 72,800 | 81,600 |
| Hay | 59,500 | 74,900 | 97,200 |
| Dry beans and peas | 12,100 | 15,400 | 19,000 |
| Sugar beets | 32,400 | 47,300 | 61,100 |
| Potatoes | 86,000 | 107,600 | 130,800 |
| Vegetables | 3,400 | 3,500 | 4,600 |
| Fruits, nuts, and berries | 400 | 600 | - |
| Forage seed, hops, and mint | 1,300 | 1,600 | 1,900 |
| Total | 257,300 | 323,700 | 396,200 |

1/ Based on projected normalized prices.

## Water

The total irrigation requirement beyond the 1966 level of development includes the amount of water needed to relieve shortages on presently irrigated lands and the amount needed to provide the full requirement for dry lands which are expected to be irrigated. By 2020, farm deliveries are expected to increase by 2.5 million acre-feet and resulting depletions will increase by 1.9 million acre-feet. These increases are shown by time periods in table 71.

### Supplemental

To provide the 510,000 acres of inadequately irrigated lands in the subregion with adequate water, an additional diversion supply of 704,000 acre-feet needs to be developed, resulting in a farm delivery of 350,000 acre-feet and a depletion of 310,000 acre-feet. The annual diversion need by tributary basin is shown in table 72.

Table 71 - Projected Farm Deliveries and Depletions, Subregion 4

| | Presently Irrigated | | Future Irrigation | | Total | |
|---|---|---|---|---|---|---|
| Year | Farm Delivery | Depletion | Farm Delivery | Depletion | Farm Delivery | Depletion |
| | | | (1,000 acre-feet) | | | |
| 1966 | 6,740 | 4,920 | | | 6,740 | 4,920 |
| 1980 | 7,090 | 5,230 | 1,290 | 950 | 8,380 | 6,180 |
| 2000 | 7,090 | 5,230 | 1,600 | 1,190 | 8,690 | 6,420 |
| 2020 | 7,090 | 5,230 | 2,110 | 1,570 | 9,200 | 6,800 |

Table 72 - Supplemental Irrigation Diversion Requirements, Subregion 4

| Subarea | Water-Short Lands (acres) | Supplemental Requirement (acre-feet) |
|---|---|---|
| Snake River above Idaho-Wyoming stateline | 113,200 | 180,000 |
| Henrys Fork basin | 48,000 | 60,000 |
| Snake River - stateline to American Falls | | |
| Main stem | | 0 |
| East side tributaries | 70,800 | 90,000 |
| Snake River - American Falls to King Hill | | |
| Main stem | | 0 |
| North side tributaries and Snake Plain | 69,000 | 150,000 |
| South side tributaries | 209,000 | 224,000 |
| Total | 510,000 | 704,000 |

Full

Farm delivery requirements and depletions vary considerably in the subregion. The smallest requirements by far are in the upper reaches of the Snake River above the Idaho-Wyoming stateline. With elevations in excess of 6,000 feet, this area is limited to production of pasture, wild hay, and some grain. Requirements in the Henrys Fork, Fall River and Teton basins are about one-third larger, reflecting more diversified cropping patterns and lower

elevations. Requirements in the remaining areas increase as lands are located farther downstream and closer to the Snake River. Unit farm delivery requirements and depletions for new lands expected to be irrigated by 2020 are shown in table 73.

*Palisades Reservoir, completed in 1958, stores 1.4 million acre-feet of water for irrigation, flood control, power, and recreation. (Bureau of Reclamation)*

## THE POTENTIAL TO MEET THE NEEDS

Subregion 4 has more irrigated land than any other subregion in the Columbia-North Pacific Region but still has many attractive opportunities for new irrigation development. The subregion contains an additional 4.5 million acres physically suited for irrigation, about 13 percent of the potentially irrigable lands in the Columbia-North Pacific Region. Of the total land resource identified as suitable for irrigation, only 36 percent is now being irrigated.

To meet the 2020 food and fiber needs, an additional 725,000 acres must be brought under irrigation in the subregion. In addition, the 510,000 acres with water shortages will have to be provided a full water supply.

Table 73 - Irrigation Requirements and Use, Subregion 4

| Area | Present-2000 Farm Delivery (AF/ac.) | Present-2000 Depletion (AF/ac.) | 2000 - 2020 Farm Delivery (AF/ac.) | 2000 - 2020 Depletion (AF/ac.) |
|---|---|---|---|---|
| Snake River above Idaho-Wyoming stateline | 1.7 | 1.3 | 1.7 | 1.3 |
| Henrys Fork basin | | | | |
| a) Henrys Fork & Fall River | 2.3 | 1.8 | 2.2 | 1.6 |
| b) Teton River | 2.3 | 1.7 | 2.2 | 1.6 |
| Snake River--stateline to American Falls | | | | |
| a) Main stem | | | | |
| Heise to Blackfoot | 2.8 | 2.0 | 2.8 | 2.1 |
| b) East side tributaries | 2.9 | 2.2 | 2.5 | 1.8 |
| Snake River--American Falls to King Hill | | | | |
| a) Main stem | | | | |
| Blackfoot to Milner | 3.0 | 2.2 | 2.9 | 2.2 |
| Milner to Hagerman | 3.6 | 2.4 | 3.1 | 2.3 |
| b) North side tributary & Snake Plain | | | | |
| Mud Lake | 2.6 | 2.0 | 2.6 | 1.9 |
| Wood & Lost Rivers & Snake Plain | 3.0 | 2.4 | 2.8 | 2.1 |
| c) South side tributaries | | | | |
| Goose Creek (Oakley Fan) & Raft River | 3.4 | 2.3 | 2.8 | 2.1 |
| Salmon Falls Creek | 3.4 | 2.3 | 2.9 | 2.2 |
| Nevada & Utah lands | 3.2 | 2.2 | 2.5 | 1.8 |

## Potentially Irrigable Lands

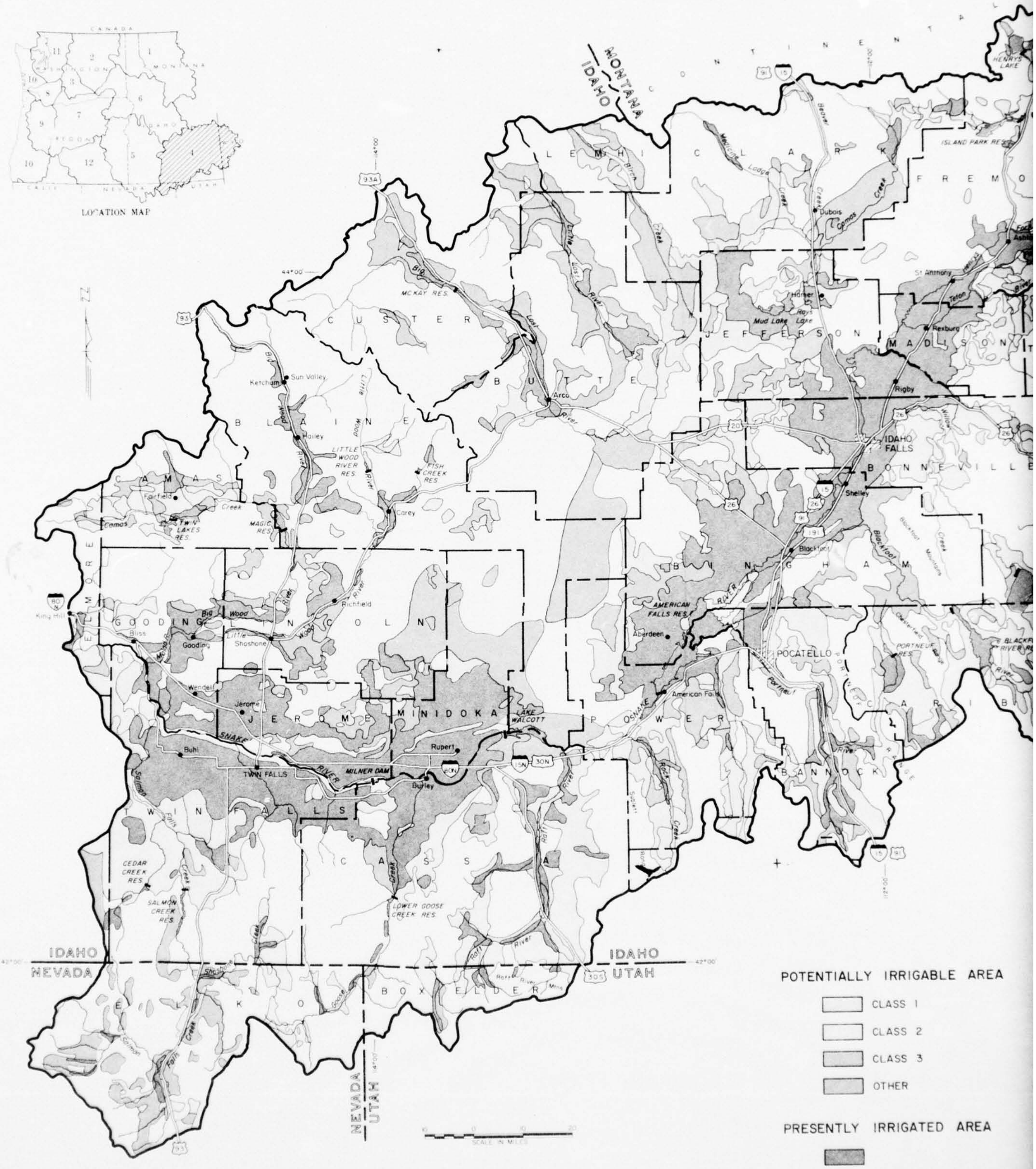
Nearly 4.5 million acres have been identified as potentially irrigable in Subregion 4 and have been placed in four irrigability classes. The first three classes are suited for agricultural uses although in some cases they may have greater potential for non-agricultural purposes. The fourth class, called "other," has 376,000 acres (12 percent) of the potentially irrigable land. Under irrigation these "other" lands would be primarily suited to producing limited forage for wildlife and livestock grazing, since they are not generally suitable for more intensive uses. Table 74 presents a breakdown of irrigability classes by states and by discussion areas. The location of these lands is shown on figure 25.

Table 74 - Potentially Irrigable Lands by States and Areas
Subregion 4

| State | Class 1 | Class 2 | Class 3 | Subtotal | Other | Total |
|---|---|---|---|---|---|---|
| | | | (acres) | | | |
| Idaho | 705,200 | 1,723,300 | 1,393,900 | 3,822,400 | 375,900 | 4,198,300 |
| Nevada | 7,400 | 50,800 | 113,000 | 171,200 | - | 171,200 |
| Wyoming | 4,600 | 9,900 | 53,300 | 67,800 | - | 67,800 |
| Utah | - | 13,200 | 12,400 | 25,600 | - | 25,600 |
| Total | 717,200 | 1,797,200 | 1,572,600 | 4,087,000 | 375,900 | 4,462,900 |
| Percent | 15 | 39 | 34 | 88 | 12 | 100 |
| Subarea | | | | | | |
| Snake River above Idaho-Wyoming stateline | 5,800 | 23,600 | 56,500 | 85,900 | - | 85,900 |
| Henrys Fork basin | 84,300 | 165,400 | 35,600 | 285,300 | - | 285,300 |
| Snake River--stateline to American Falls | | | | | | |
| Main stem | 37,200 | 56,600 | 93,600 | 187,400 | - | 187,400 |
| East side tributaries | 64,000 | 372,300 | 219,100 | 655,400 | - | 655,400 |
| Snake River--American Falls to King Hill | | | | | | |
| Main stem | 81,200 | 209,900 | 149,000 | 440,100 | 35,700 | 475,800 |
| North side tributaries & Snake Plain | 269,500 | 472,000 | 715,800 | 1,457,300 | 340,200 | 1,797,500 |
| South side tributaries | 175,200 | 497,400 | 303,000 | 975,600 | - | 975,600 |
| TOTALS | 717,200 | 1,797,200 | 1,572,600 | 4,087,000 | 375,900 | 4,462,900 |

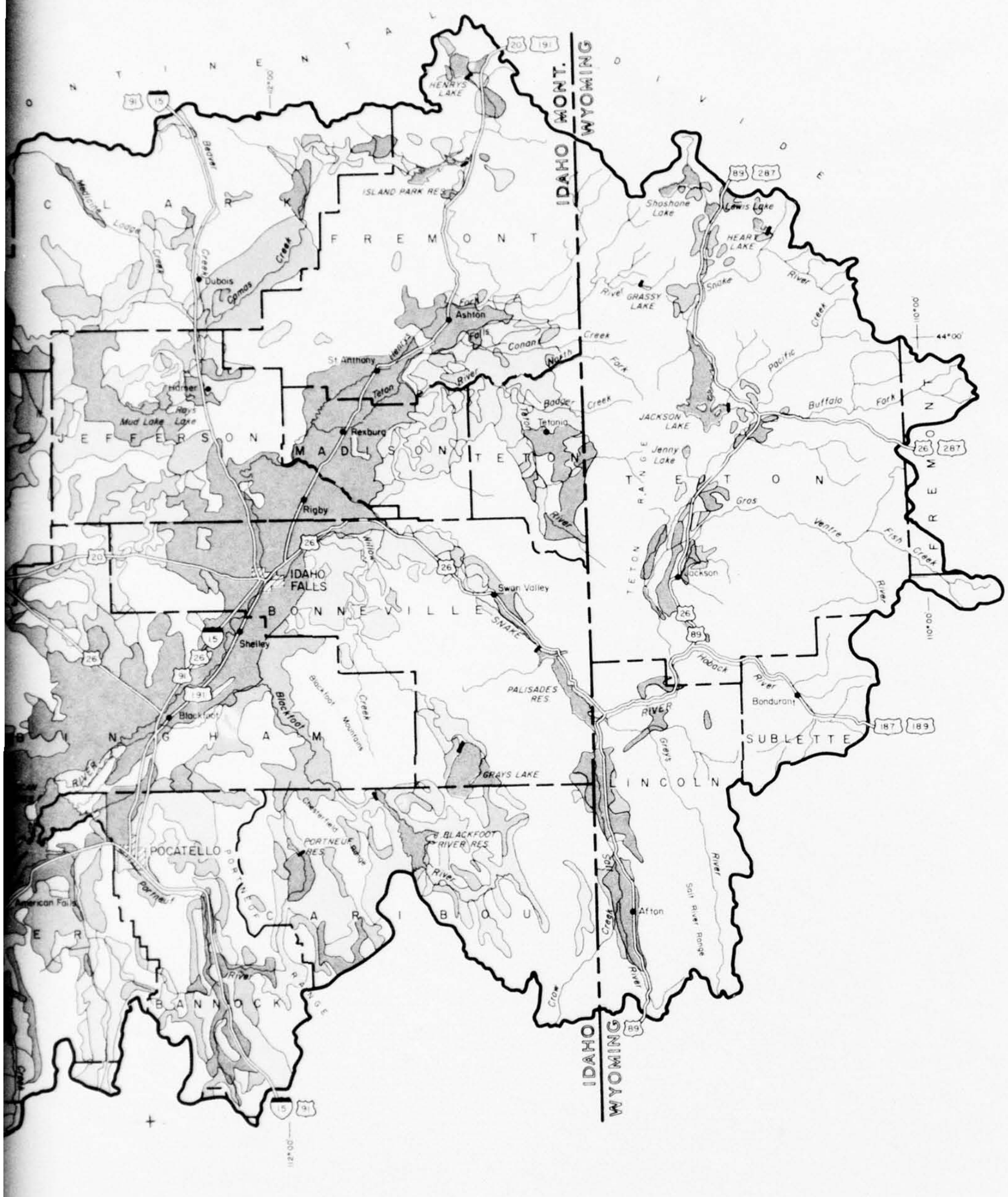
## Class 1

Class 1 lands total 717,200 acres, 15 percent of the total potentially irrigable area. The class 1 lands are about evenly divided among the mountain valleys, the upper Snake Plain, and the lower Snake Plain. These are the highest quality lands classified; with adequate irrigation, they will produce good to excellent yields of all climatically adapted crops.



LOCATION MAP
MONTANA
IDAHO
CONTINENTAL
IDAHO
NEVADA
IDAHO
UTAH
NEVADA
UTAH
POTENTIALLY IRRIGABLE AREA
CLASS 1
CLASS 2
CLASS 3
OTHER
PRESENTLY IRRIGATED AREA
SCALE IN MILES
CUSTER
BLAINE
BUTTE
CAMAS
GOODING
LINCOLN
JEROME
MINIDOKA
TWIN FALLS
CASSIA
JEFFERSON
MADISON
BONNEVILLE
BINGHAM
POWER
BANNOCK
CARIBOU
LEMHI
CLARK
FREMONT
ELMORE
ELKO
BOX ELDER
SNAKE RIVER
MILNER DAM
LAKE WALCOTT
AMERICAN FALLS RES.
IDAHO FALLS
POCATELLO
TWIN FALLS
Mud Lake
ISLAND PARK RES.
HENRYS LAKE
LOWER GOOSE CREEK RES.
CEDAR CREEK RES.
SALMON CREEK RES.
LITTLE WOOD RIVER RES.
FISH CREEK RES.
MAGIC RES.
MCKAY RES.
PORTNEUF RES.

2




POTENTIALLY IRRIGABLE AREA

CLASS 1

CLASS 2

CLASS 3

OTHER

PRESENTLY IRRIGATED AREA

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# POTENTIALLY IRRIGABLE AREA

UPPER SNAKE, SUBREGION 4

1968

FIGURE 25

Most of the class 1 soils have developed from windlaid silt, while others have developed from alluvial and glacial materials. The soils are mostly medium-textured silt loams. The soils are free of harmful salts and well drained. Most of these lands have gently rolling topography.

### Class 2

Class 2 lands total 1,797,200 acres, 39 percent of the potentially irrigable lands. Nearly half of these lands are located in the high mountain valleys, with the remainder about evenly divided between the upper and the lower Snake Plain. These good-quality lands are suitable for most climatically adapted crops, but they will either produce lower yields than the class 1 lands or require greater costs to produce equal yields. Under irrigation, lands of this quality in the high mountain valleys produce mainly forage and small grains; class 2 lands on the Snake River Plain will produce a wider range of crops.

Most of the class 2 lands have soils which are shallower than those of the class 1 lands. Some class 2 lands have topographic deficiencies; because of steep gradients on some of the lands, special management practices are often required, even with sprinkler irrigation.

### Class 3

Class 3 lands total 1,572,600 acres, 34 percent of the subregion's potentially irrigable lands. Over half of these lands are located in the high mountain valleys; the remainder are about evenly divided between the upper and the lower Snake River Plain. These lands are of only fair quality; under irrigation, they are best suited for the production of pasture and forage crops.

The high mountain valley lands are either steep, rocky, or shallow. On the Snake River Plain, class 3 lands are often shallow to gravel or hardpan; some lands also have rock outcrops or are stony. The soils are generally free of concentrations of harmful salts, are neutral to moderately alkaline, and are usually well drained. Sprinkler irrigation will be required on many of the class 3 lands because of steep slopes.

### Other

In addition to the lands included in the above classification, 375,900 acres of lands have been identified as having a long-range potential for range forage production or wildlife habitat improvement

under irrigation. Though these lands generally do not meet the minimum criteria established for agricultural use, they are included in order to identify the ultimate potential in the subregion.

## Water Supply

The discharge of the Snake River at the lower end of the subregion is about 6 million acre-feet annually. This figure reflects depletions of almost 5 million acre-feet annually, practically all of which is for irrigation.

The basaltic volcanic rocks of the Snake Plain and adjacent alluvial deposits support the most extensive ground water development in the entire region. They contain about three-fourths of the subregion's 100 million acre-feet of ground water at depths varying from 50 to 100 feet below the water table. Considerably more ground water is available at greater depths. Gross annual recharge of ground water in the subregion is about 18 million acre-feet of which 15 million acre-feet is to the two major aquifers mentioned above. Some water cycles in and out of aquifers at least three times as it moves from the upper end of the subregion to the lower end. Thus net annual recharge of the two major aquifers is on the order of 8 or 10 million acre-feet.

## Potential Developments

Part of the subregion's irrigation requirement can be provided through large Federal projects, but a substantial share must be developed by smaller project works or through private individual and group efforts. Based on projected needs, an average of some 40,000 acres of new land must be irrigated each year in order to meet the 1980 need of an additional 435,000 acres. This is 60 percent of the 2020 subregional need of 725,000 acres. This rate will be very difficult to attain. Over the succeeding 20 years, the needed rate of development drops to only 5,000 acres annually; and from 2000 through 2020, the rate would increase to 9,000 acres annually. The average required rate of increase through 2020 is approximately 15,000 acres annually. Development at this rate will not be too difficult to attain.

Surface flows in all of the water courses in this subregion have been appropriated to the extent that a dependable supply for new irrigation cannot be obtained without provision for storage. In several of the drainage basins north of the Snake River, such as the Lost River and Wood River Basins, new irrigation can be accomplished by storage and diversion of surface water alone. Also, most of these areas, as well as the extensive undeveloped lands over the Snake Plain aquifer, can obtain adequate irrigation supplies

from ground water with moderate pump lifts. Individuals, small groups, and Federal programs may thus continue to develop lands in this area for some time by constructing new irrigation works.

This flexibility is not possible in most of the rest of the subregion, however, because in many areas all surface water is now committed during years of low runoff. In other areas adjoining presently irrigated lands along the fringes of the Snake Plain, the only apparent source of new supplies is ground water. In most of these areas, enough ground water is available that drawdown of the water table should not be a problem with substantial amounts of new development.

## Development by Subarea

Subareas where project-type development may occur are in the Henrys Fork basin and along the south side tributaries of the Snake River such as Raft River, Goose Creek (the Oakley Fan area), and Salmon Falls Creek.

Snake River above Idaho-Wyoming Stateline This subarea contains less than 90,000 acres of potentially irrigable land, of which approximately 70,000 acres is in Wyoming. Since these lands are located at rather high elevations and have relatively short growing seasons, it is anticipated that only a moderate amount of new land will be irrigated by 2020.

In general, a plentiful surface water supply originates in this subarea; an average of 3.4 million acre-feet of Snake River flows pass the stateline annually. While most of this water is committed for use downstream, a maximum of 4 percent has been reserved through the Snake River Compact of 1949 for diversion in Wyoming within the Snake River drainage. In many cases the water does not occur when and where needed for direct diversion; therefore, additional storage reservoirs and diversion facilities will be needed to satisfy both the existing supplemental water needs and new development requirements. However, this subarea has heavy recreation use and many interests consider undesirable the construction of additional reservoirs.

Henrys Fork Basin Over 280,000 acres of potentially irrigable land lie within the Henrys Fork basin. The basin has an average annual discharge of about 1.1 million acre-feet at Rexburg, but additional storage facilities would have to be built in order to provide adequate supplies through the irrigation season.

The potential exists for increased use of ground water in this subarea. Any large-scale ground water developments would have to be accompanied by analysis of the possible depletions to committed downstream flows.

Snake River - Stateline to American Falls  This subarea contains nearly 190,000 acres of potentially irrigable lands; most of these lands are at elevations well above the sources of surface water supply. Diversions to these lands will require expensive irrigation facilities. To further use surface flows for new developments, additional storage will be needed, as well as a companion ground water supply for use during dry years.

East Side Tributaries  The primary east side tributaries of the Snake River from the stateline to American Falls are Willow Creek, Blackfoot River, Portneuf River, and Bannock Creek. These streams discharge an annual average of approximately 400,000 acre-feet primarily irrigation return flows. Most of the remaining discharge is floodflows; additional storage is required to make these flows usable in the subarea.

This subarea contains over 650,000 acres of potentially irrigable lands. It appears that ground water cannot be relied upon as a dependable water supply except perhaps in portions of the Portneuf and Blackfoot drainages. The limited local ground water supply, the lack of an adequate surface water supply originating within the subarea, and the inaccessibility to Snake River surface water all limit potential development.

American Falls to King Hill  This subarea contains approximately 475,000 acres of potentially irrigable lands. The potentially irrigable lands north of the Snake River are located on the Snake Plain beyond the presently irrigated area; those south of the river are located along tributary streams where surface supplies are already committed. New lands developed would therefore have to be irrigated from ground water or through water exchanges.

North Side Tributaries and Snake Plain  In addition to the Wood River drainages, this north side subarea includes the drainages of all the "lost rivers" which have no surface connection with the Snake River. This subarea contains nearly 1.8 million acres of potentially irrigable lands, over a third of the potentially irrigable lands in the subregion. The most likely new developments on the Snake Plain are expected along the fringes of the presently irrigated lands.

The Snake Plain is underlain by one of the most productive ground water aquifers in the world. It is estimated that the aquifer discharges approximately 2,500 cubic feet per second in the reach above American Falls Dam and about 6,500 c.f.s. in the area from Twin Falls to Bliss--a total discharge of 6.5 million acre-feet per year. A large amount of the 4.7 million acre-foot discharge below Twin Falls is not now being used for consumptive purposes. It appears that considerable additional irrigation use can be made of this ground water resource.

South Side Tributaries The south side tributaries of the Snake River include the Rock Creek, Raft River, Goose Creek, and Salmon Falls Creek. The water supply originating within this subarea is insufficient even for the existing level of irrigation development.

Importation of water, probably from the Snake River, is an attractive and likely solution to the existing water supply problems of this subarea. Importation is also the key to the irrigation of the subarea's high quality land resource--approximately a million acres of potentially irrigable lands, nearly 70 percent of which are of class 1 or 2 quality.

## Private Development

Existing irrigation developments have appropriated nearly all of the surface flows in the Upper Snake Subregion. To continue irrigation development in western Wyoming and southeastern Idaho, storage will be required if a dependable water supply is to be provided for new irrigation.

In the Lost and Wood River basins and other drainage areas north of the Snake River, new lands can be developed through storage of surface flows. Ground water is also available in this area through moderate pump lifts. Private development of these new land resources is expected to continue for a number of years.

## State Development

The State of Idaho through its Water Resource Board is furnishing technical assistance to the numerous private developments and is working closely with the Federal Government in its project-type development program.

## Federal Development

Several studies at the Federal level have been made for projects in the Henrys Fork subarea. One current such study is the Lower Teton Division, a project designed to relieve water shortages on over 100,000 acres of irrigated land at the upper end of the Snake River Plain along the Henrys Fork and Teton Rivers. Preconstruction planning on this project is nearly complete. The key project feature will be the 288,500 acre-foot Teton Reservoir, which will provide flood control, power, and recreation in addition to irrigation. Later stages of the project will include the facilities to irrigate over 35,000 acres of dry land.

Concentrated use of the Snake Plain aquifer will produce a situation where private and Federal project features are intermingled and drawing from the same supply. Much of this aquifer occurs where there are few lands suitable for future development. Conveyance systems from the aquifer to the new lands and exchanges of water from one source to another will have to be developed. In addition, an increased demand on the aquifer in some areas will make regulated artificial recharge desirable. Plans have been identified to recharge the aquifer in certain areas with floodflows from the Henrys Fork and Snake River in years of above average runoff. Preliminary studies indicate that artificial recharge of the Snake Plain aquifer would reduce the pump lifts required on a substantial portion of the lands now irrigated by pumping from that source. In addition, it is estimated that the reduced pump lifts made possible by recharge would facilitate the irrigation of as much as a quarter of a million acres of desert land through either individual or project-type development.

LOCATION MAP

# SUBREGION 5

# SUBREGION 5

# CENTRAL SNAKE

## THE SETTING

Southwestern Idaho, southeastern Oregon and a small portion of northern Nevada make up Subregion 5. Its area is more than 36,800 square miles; 52 percent is in Idaho, 38 percent in Oregon and 10 percent in Nevada.

The subregion includes the drainage area of the Snake River along a 280-mile reach from King Hill, Idaho, downstream to a point below Oxbow Dam on the Idaho-Oregon border. The Snake River's tributaries include the Bruneau, Owyhee, Boise, Malheur, Payette, Weiser, Burnt and Powder Rivers.

To simplify presentation, Subregion 5 has been divided into eight subareas. Figure 26 shows this breakdown. In some instances, these eight subareas have been grouped into three categories the Snake River main stem, south and west side tributaries and north and east side tributaries.

The subregion contains the downstream half of the Snake River Plateau. Called the "Payette section," this portion of the plateau extends from the eastern boundary of the subregion west to the town of Weiser. The lava flows in this section are covered by lakebed and alluvial sediments. Because of the erosive qualities of these sedimentary materials, much of the Payette section is deeply dissected by the Snake River and its tributaries, particularly those from the south. From a deep canyon cut in the upstream portion of the subregion, the Snake River emerges into a broad and flat valley which is joined by the valleys of the Boise, Payette, Weiser, Owyhee, and Malheur Rivers. See figure 27.

Much of the subregion has a semiarid climate; summers are hot and dry and winters are cool. At the lower elevations, the climate favors production of a wide variety of high-value crops, including specialty crops and fruits. The growing season in the lower valleys ranges up to 180 days or more. Much of the Snake River Plateau receives less than 10 inches of precipitation annually, and most falls during the winter.

Land areas of the subregion are characteristic of those found in semiarid climates. More than 70 percent are used as rangelands, more than 75 percent of which is in public ownership.

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COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
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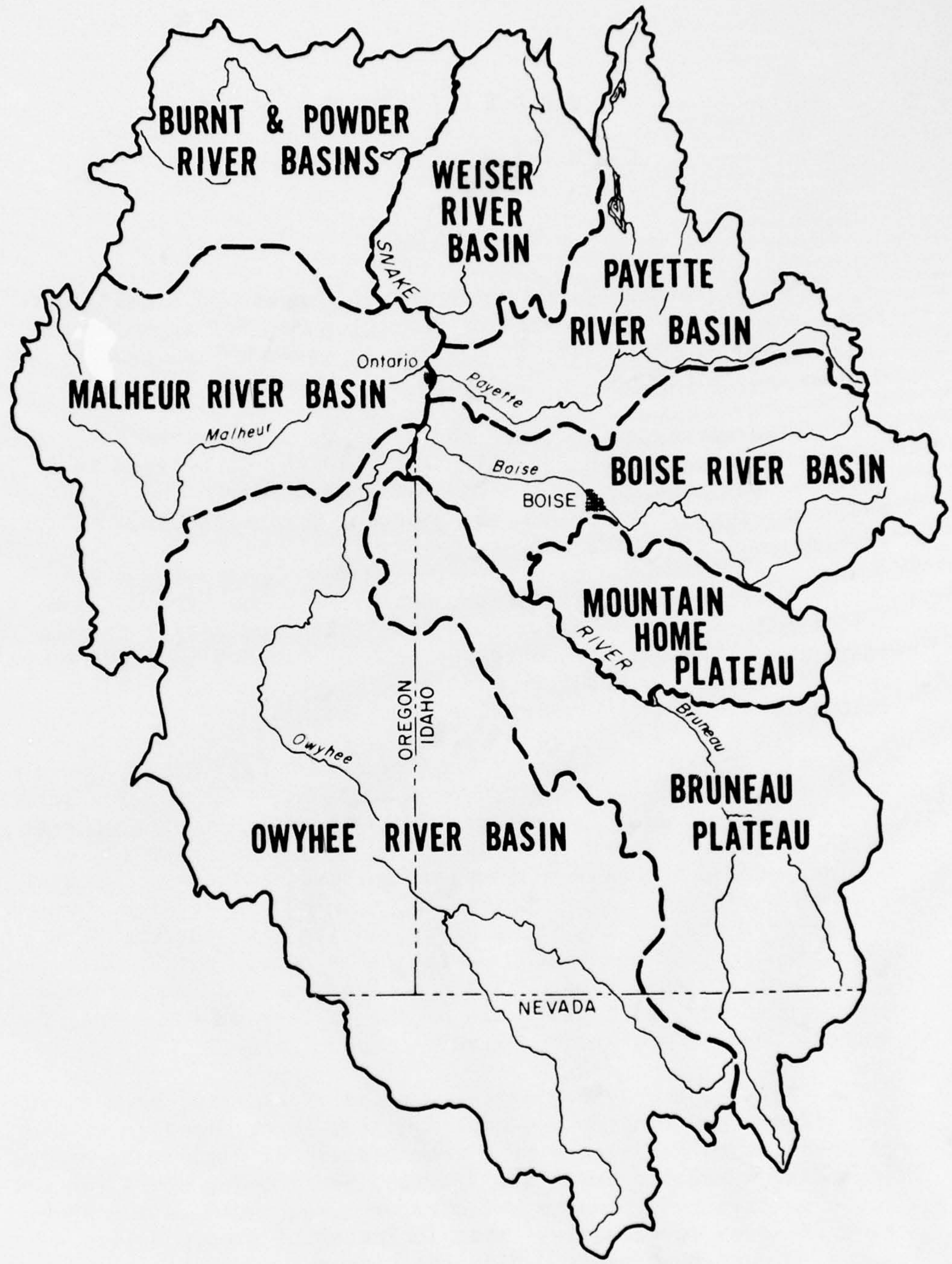



FIGURE 26. Subareas in Subregion 5, Central Snake.

Forest land is second in acreage and most of it is in public ownership. Less than 10 percent of the land area of Subregion 5 is devoted to crop production. Agriculture is concentrated in the valleys of the Snake, Boise, Payette, Malheur, Weiser and Powder Rivers.

Nearly 270,000 people live in Subregion 5. Most of the subregion has few inhabitants; major areas of concentration occur in the valleys. Boise, Nampa, Caldwell and Mountain Home in Idaho and Ontario and Baker in Oregon are the major communities.

The major transcontinental highway and railroad network roughly parallels the Snake River through the subregion. State and local highways and branch lines of the railroad reach out to much of the remaining area in the subregion. Boise and Ontario are served by commercial airlines.

Agriculture, forestry and food processing are the principal areas of employment. The subregion is dependent upon the relatively small agricultural area for the basis of its economic activity.

Irrigation began in many areas of the subregion in the early 1860's coinciding with early gold discoveries. Irrigation began in the Boise and Payette River valleys in 1863; all the lower lying lands along the streams were irrigated within just a few years. Extensive diversion and canal systems were built with group and corporation financing to reach lands lying further from the rivers. By 1900, some 150,000 acres were under irrigation in the Boise and Payette valleys.

To expand irrigation, construction on the first works of the Boise Reclamation Project began soon after passage of the Reclamation Act in 1902. Since then, many additions have been made to the project, making it the largest in Subregion 5. This project now stores Boise and Payette River water in five major reservoirs, including Arrowrock and Anderson Ranch on the Boise River and Cascade on the Payette River, to provide all or part of the water supply for some 350,000 acres.

The Boise and Payette Rivers are used to irrigate more than a half million acres of land. In total, more than a third of the irrigated lands in the subregion receive all or part of their water supply from Federally financed projects. The Owyhee Reclamation Project, the second largest in the subregion, serves over 100,000 acres at the lower end of the Owyhee River drainage. The project's lands are served both from regulated flow of the Owyhee River and by pumping from the Snake River.

Both private and Federal development are found throughout much of the subregion. In the lower portion of the Malheur River drainage, the Vale Reclamation Project provides water to over 30,000 acres. In the upper portion of the drainage, private developers have built many small reservoirs to improve the water supply for relatively small and scattered tracts.

Irrigated lands are located in several valleys along the Powder River. The Baker Reclamation Project, including the recently constructed Mason Dam, serves about 25,000 acres in the Baker Valley. In the Burnt River basin, the Burnt River Reclamation Project provides supplemental water supplies for 15,000 acres. The Duck Valley Irrigation Project serves lands in Idaho and Nevada near the headwaters of the Owyhee River drainage, and the recently constructed Mann Creek Reclamation Project has relieved water shortages on lands in the lower Weiser River basin.

By the end of World War II, approximately 1 million acres had been irrigated in the Central Snake Subregion. These lands were primarily limited to river valleys and other lower lying lands.

*Irrigated farms have been well established for many years in the Boise Valley and nearby areas. Without irrigation, only sagebrush and drouth-resistant grasses would grow on these lands. (Bureau of Reclamation)*

Since that time, an additional half million acres have been irrigated, yielding an average annual increase of over 20,000 acres. However, development in recent years has exceeded this average considerably because of the demonstrated feasibility of high-lift pumping from the Snake River, with pump lifts often

exceeding 500 feet. Thousands of acres of the higher Snake River Plateau lands can be served by pumping from the Snake. Because of the large investments required, much of the high-lift pumping from the Snake River has been group- or corporation-financed and the irrigated lands are in large blocks. The great success of these developments has resulted in a large number of applications for public land under the Desert Land Act, particularly in the area south of the Snake River.

## PRESENT STATUS

Irrigation agriculture is the most important single element of the economy of Subregion 5, and irrigation is the largest user of water. Irrigation agriculture and its related food processing and service industries are the basis of an economy which supports 270,000 people, nearly all of whom live in the irrigated valleys of the subregion.

A total of 1,465,000 acres was irrigated in the Central Snake Subregion in 1966, according to studies made by the Soil Conservation Service and the Bureau of Reclamation. The irrigated acreages by source and adequacy of supply and method of irrigation are shown in table 75. Included are small acreages for forest nurseries, seed orchards, recreation sites and tracts used for wildlife and other purposes. Idaho has 60 percent of the subregion's irrigated lands, Oregon has 30 percent, and Nevada has 10 percent.

Table 75 - Irrigated Area, 1966, Subregion 5

| State | Surface Water Adeq. Supply | Surface Water Inadeq. Supply | Ground Water Adeq. Supply | Ground Water Inadeq. Supply (Acres) | Method of Irrigation Sprinkler | Method of Irrigation Gravity | Total |
|---|---|---|---|---|---|---|---|
| Idaho | 745,000 | 73,000 | 62,000 | -- | 106,000 | 774,000 | 880,000 |
| Oregon | 259,000 | 173,000 | 6,000 | -- | 13,000 | 425,000 | 438,000 |
| Nevada | -- | 147,000 | -- | -- | | 147,000 | 147,000 |
| Total | 1,004,000 | 393,000 | 68,000 | -- | 119,000 | 1,346,000 | 1,465,000 |

Source: Bureau of Reclamation and Soil Conservation Survey data.

Irrigation from surface supplies is predominant; only 5 percent of the irrigated lands are served from ground water. Over one-fourth of the lands irrigated by surface water are inadequately supplied; all lands served from ground water are considered adequately supplied.

## Characteristics of Irrigated Areas

As shown on figure 27, two-thirds of the subregion's irrigated area is concentrated in the valleys of the Snake, Boise, Payette, Weiser, Owyhee, and Malheur Rivers and extends generally from Boise on the east to Vale, Oregon, on the west. Half of this irrigated area is within the Boise and Payette River valleys. Irrigation is well established in this area, and good yields of a wide variety of high value crops are produced.

Other areas of notable irrigation development include the scattered blocks of land along the Snake River between King Hill and Murphy, Idaho; lands in the upper Payette River basin south of McCall and near Cascade Reservoir in Idaho; lands along the upper Weiser River around Council, Idaho; and along the Powder River downstream from Baker, Oregon.

According to the 1964 Census of Agriculture there were 10,400 farms in the economic study area, of which 9,600 were classified as irrigated. The economic study area consists of Ada, Adams, Boise, Canyon, Elmore, Gem, Owyhee, Payette, Valley and Washington counties in Idaho; and Baker and Malheur counties in Oregon. While the irrigated farms in the subregion vary greatly, the typical farm is a diversified operation containing a combination of field crop and livestock enterprises.

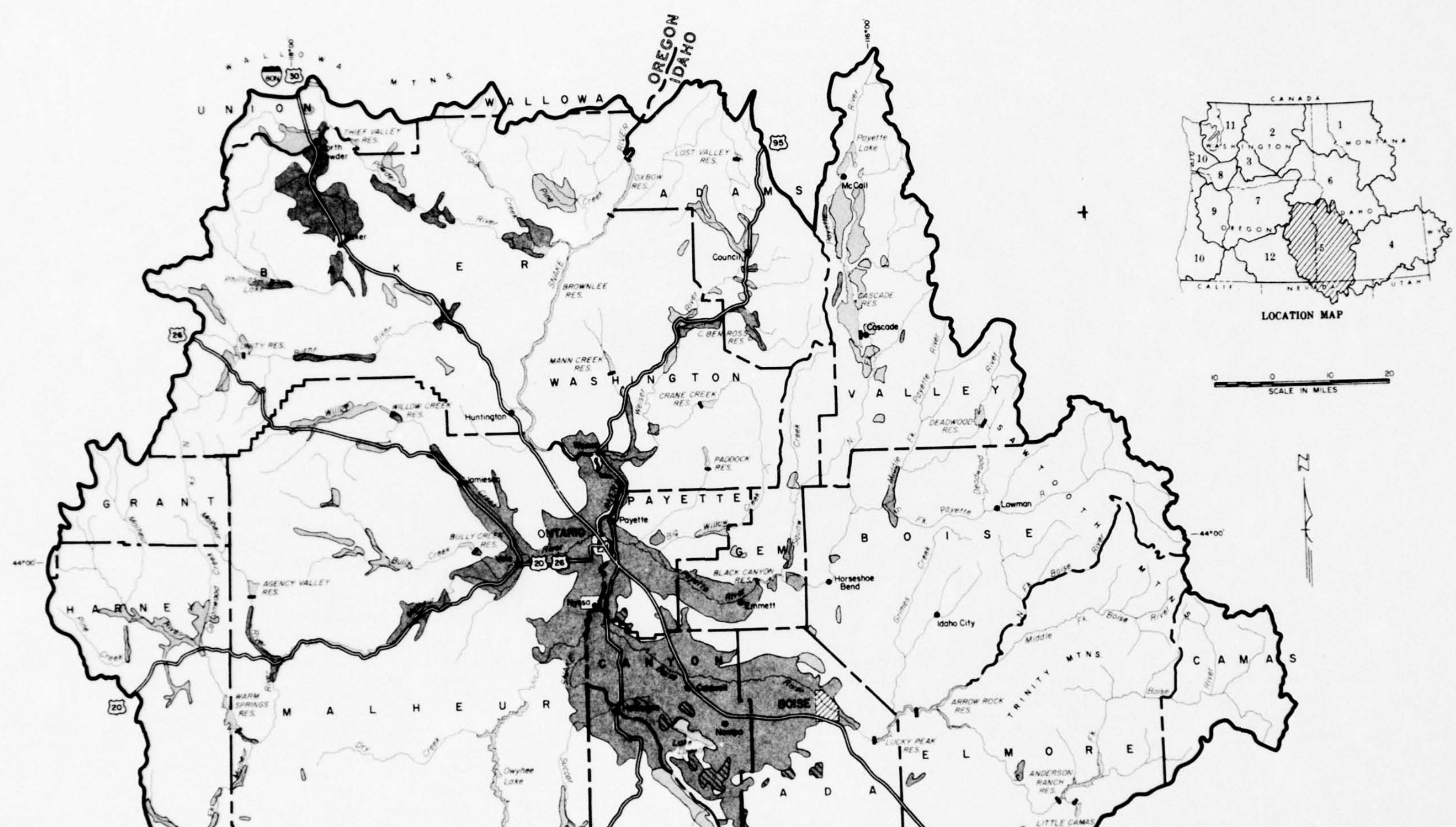
The total land area in the 9,600 irrigated farms was about 5.4 million acres, of which only about 19 percent was actually irrigated. The average size farm was 560 acres, with 106 acres irrigated per farm.

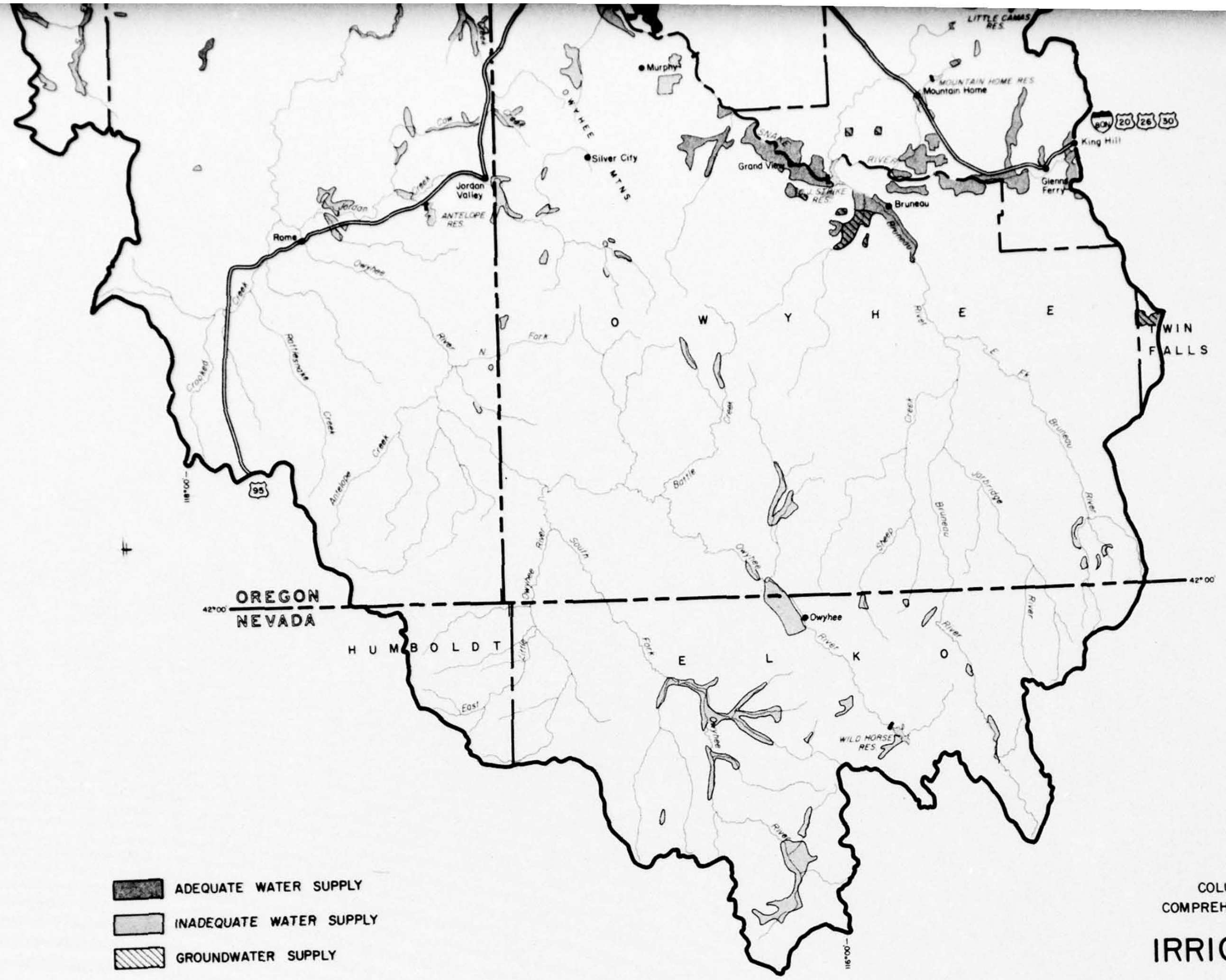
Figure 28 shows a proportional breakdown of irrigated cropland harvested and pasture grown in the subregion in 1964. Seventy-six percent of the irrigated land was used to grow grains and forage, 16 percent was used for the major field crops, and the remainder was used to grow fruits, vegetables, and other crops.

## Production of Irrigated Crops

A comparison of irrigated crop production with total production indicates the importance of irrigation to the subregion. Sugar beet production in 1964 totaled over 1.4 million tons, nearly a third of the sugar beets grown in the Columbia-North Pacific Region. Several counties in the subregion rank with the top sugar beet producing counties in the United States.

Under irrigation large yields of other crops are produced including potatoes, alfalfa, onions, and many fruit varieties. In 1964, Subregion 5 produced 14 percent of the potatoes and nearly


LOCATION MAP
SCALE IN MILES
CANADA
WASHINGTON
OREGON
MONTANA
IDAHO
NEVADA
UTAH
CALIF
OREGON
IDAHO
WALLOWA MTNS
UNION
WALLOWA
BAKER
ADAMS
VALLEY
WASHINGTON
PAYETTE
GEM
BOISE
CAMAS
ELMORE
ADA
CANYON
MALHEUR
GRANT
HARNEY
OWYHEE
TWIN FALLS
TRINITY MTNS
OWYHEE MTNS
BOISE
ONTARIO
Payette
Emmett
Nampa
Horseshoe Bend
Idaho City
Lowman
McCall
Cascade
Council
Huntington
Murphy
Silver City
Grand View
Bruneau
Mountain Home
Glenns Ferry
King Hill
Jordan Valley
Rome
Jamieson
BROWNLEE RES.
OXBOW RES.
LOST VALLEY RES.
CASCADE RES.
DEADWOOD RES.
MANN CREEK RES.
CRANE CREEK RES.
PADDOCK RES.
BLACK CANYON RES.
ARROW ROCK RES.
LUCKY PEAK RES.
ANDERSON RANCH RES.
LITTLE CAMAS RES.
MOUNTAIN HOME RES.
BULLY CREEK RES.
AGENCY VALLEY RES.
WARM SPRINGS RES.
WILLOW CREEK RES.
THIEF VALLEY RES.
ANTELOPE RES.
Owyhee Lake
Payette Lake
44°00'
116°00'




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# IRRIGATED AREA

CENTRAL SNAKE, SUBREGION 5

1968

FIGURE 27

2

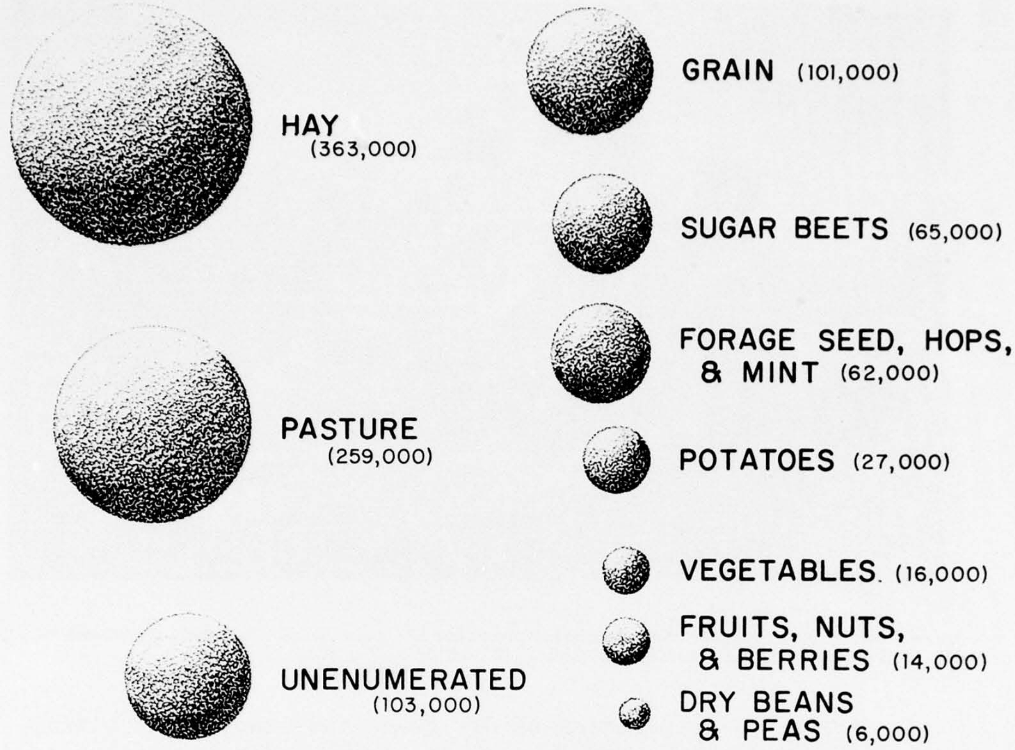



FIGURE 28. Acreage of Irrigated Cropland Harvested and Pasture, 1964, Subregion 5.

20 percent of the vegetables grown in the Columbia-North Pacific Region. Two counties in the subregion ranked among the leaders in the United States in the value of all farm products sold; six counties ranked among the top 75 in the Nation in production of prunes and plums; and three counties ranked with the 50 leaders in apple production. The production of high value seed crops is of great importance; for example, Canyon County alone produces most of the Nation's hybrid sweet corn seed.

Livestock production and dairying are also vital to the economy of the subregion. Although irrigation is not a prerequisite for livestock production, the increased feed production resulting from irrigation permits the raising of much more livestock than would otherwise be possible. Livestock-related industries, such as feed manufacturing, meat packing, and milk and cheese processing, are numerous in the subregion.

*A good crop of sweet corn is being harvested from this irrigated field; Subregion 5 produces nearly all of the Nation's hybrid sweet corn seed. (Bureau of Reclamation)*

All of the production of dry beans and peas, sugar beets, potatoes, vegetables, and fruits were grown under irrigation in 1964. In addition, about 78 percent of the small grains, forage seed, hops, and mint and nearly 90 percent of the hay were also grown under irrigation. A summary of crop production for 1964 is presented in table 76.

Table 76 - Summary of Crop Production, 1964, Subregion 5

| Crop Category | Units | Production Total (1,000's) | Production Irrigated (1,000's) | Percent Irrigated |
|---|---|---|---|---|
| Small grains | tons | 205 | 161 | 78.5 |
| All hay | tons | 1,144 | 1,025 | 89.6 |
| Dry beans and peas | cwt. | 112 | 112 | 100 |
| Sugar beets | tons | 1,448 | 1,448 | 100 |
| Potatoes | cwt. | 7,648 | 7,648 | 100 |
| Vegetables | cwt. | 3,806 | 3,806 | 100 |
| Fruits, nuts, and berries | tons | 54 | 54 | 100 |
| Forage seed, hops, and mint | lbs. | 26,106 | 20,234 | 77.5 |

Source: Derived from Census of Agriculture and Agricultural Statistics.

Yields of selected irrigated crops are presented in table 77.

Table 77 - Yields for Selected Major Irrigated Crops in 1964, Subregion 5

| Crop | Unit | Yield per Irrigated Acre |
|---|---|---|
| Small grains and hay | | |
| Wheat | tons | 1.68 |
| Barley | tons | 1.27 |
| Alfalfa | tons | 3.4 |
| Other field crops | | |
| Potatoes | cwt. | 284 |
| Dry beans | cwt. | 17.5 |
| Sugar beets | tons | 22.4 |

*Large yields of onions and other high-value crops are produced on the irrigated lands of the sub-region. (Bureau of Reclamation)*

## Value of Production

The total value of production associated with irrigated land was estimated at $121 million in 1964. This amount consisted of crops valued at $66 million and livestock and livestock products associated with feed crops grown on irrigated land which amounted to $55 million. Field crops such as potatoes and sugar beets made up the major share of crop value with meat animals contributing the major share to livestock and livestock values.

## Economic and Social Impacts

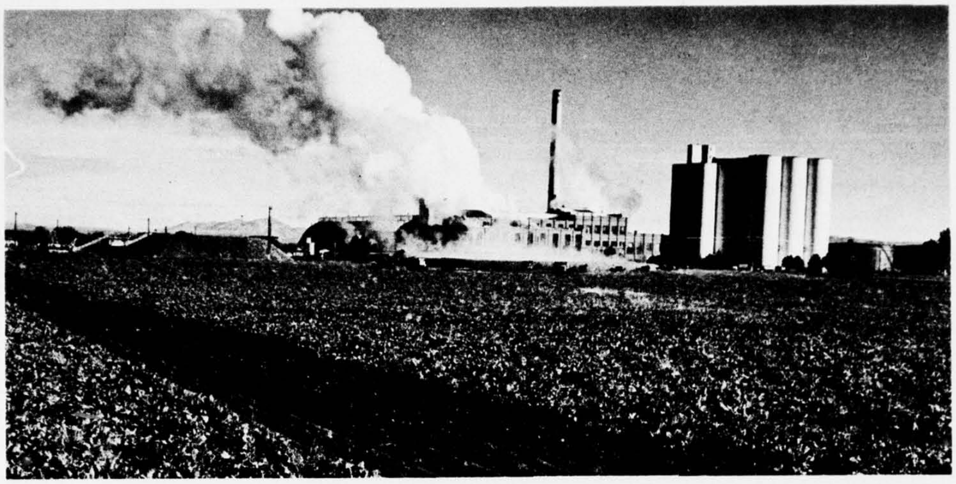
Agri-business, consisting primarily of irrigated agriculture and associated service and processing activities, is the major industry in the subregion. Sugar refining, which depends entirely on irrigated agriculture for sugar beets, has long been an important industry in the subregion. Potato processing, which has been more recently introduced, has broadened the marketing area for local potatoes and is providing employment for several thousand people.

The local vegetable seed industry also depends heavily on irrigation both for quantity and quality of product. This subregion is a major supplier of the Nation's needs for vegetable seeds. It is also a major producer of dry onions for the fresh market. All of these crops are grown exclusively under irrigation.

An estimate of the dollar value of the impact from irrigation was made by applying results of a study of the Columbia Basin Project area in Eastern Washington. That area has an economy similar to that of Subregion 5. The estimated gross economic impact of irrigated agriculture is presented in table 78.

Table 78 - Gross Value of Agricultural Products and Services Associated With Irrigation Use in 1964, Subregion 5

| Industry | Gross Value (millions) |
|---|---|
| Irrigated agriculture | $121 |
| Processing | 103 |
| Trades and services | 206 |
| Total | $430 |



*The sugar beets grown in this field provide part of the supply required by this Nampa, Idaho, sugar factory; Subregion 5 produces nearly a third of the sugar beets grown in the Columbia-North Pacific Region. (Bureau of Reclamation)*

## Use of Water

About 90 percent of the water diverted for irrigation is obtained from streams tributary to the Snake River. The source of most of this water is snowmelt from high elevation forest areas. Because the snowpack is normally depleted by the middle of the irrigation season, streamflows become inadequate; therefore, it is necessary to augment late summer supplies with storage water on most tributaries. Late season streamflow deficiencies have been partially met by storage releases from tributary reservoirs having active capacities totaling more than 4.5 million acre-feet. Ground water is presently used only on a small amount of land scattered throughout the subregion.

The subregion has been divided into three areas for analysis of water use: (1) the main stem of the Snake River, (2) the south and west side tributaries, and (3) the north and east side tributaries. All aspects of present irrigation water use are summarized in table 79 and discussed in the following sections.

About 6.4 million acre-feet of water are diverted annually for irrigation. On the average, 71 percent of these diversions are from natural streamflows, 26 percent are from stored water, and the remaining 3 percent are from ground water.

(1) Snake River--main stem. Lands irrigated from the Snake River are supplied primarily by large pumping plants which lift the

Table 79 - Use of Water for Irrigation, 1966 Level, Subregion 5

| Item | Unit | Snake River Main Stem | South & West Side Tributaries | North & East Side Tributaries | Sub-Region Totals |
|---|---|---|---|---|---|
| Surface Water | | | | | |
| Lands with Adequate Supply | | | | | |
| Area | acres | 188,400 | 313,400 | 502,200 | 1,004,000 |
| Natural flow | ac-ft | 586,600 | 916,000 | 1,883,000 | 3,385,600 |
| Storage use | ac-ft | 0 | 515,000 | 1,091,000 | 1,606,000 |
| Lands with Inadequate supply | | | | | |
| Area | acres | 18,800 | 335,400 | 38,800 | 393,000 |
| Natural flow | ac-ft | 58,400 | 919,000 | 150,000 | 1,127,400 |
| Storage use | ac-ft | 0 | 40,000 | 0 | 40,000 |
| Shortage | ac-ft | 25,000 | 435,000 | 44,000 | 504,000 |
| Ground Water | | | | | |
| Area | acres | 17,300 | 14,800 | 35,900 | 68,000 |
| Diversion | ac-ft | 53,700 | 46,000 | 111,300 | 211,000 |
| Total Area Irrig. | acres | 224,500 | 663,600 | 576,900 | 1,465,000 |
| Total Diversions | ac-ft | 698,700 | 2,436,000 | 3,235,300 | 6,370,000 |
| Return Flow | ac-ft | 204,700 | 1,109,000 | 2,081,300 | 3,395,000 |
| Depletion | ac-ft | 494,000 | 1,327,000 | 1,154,000 | 2,975,000 |

Source: Bureau of Reclamation and Soil Conservation Service data.

water 200 to 600 feet to the adjacent farmland. Some lands in this area are served from ground water and others obtain supplies from minor tributaries.

Since its inflow to the subregion at King Hill is over 6 million acre-feet annually, the natural flow of the Snake River is adequate to meet the demands of lands served by diversions from that source. No reservoirs have been built for irrigation storage on the main stem.

(2) South and west side tributaries. The major tributaries of the Snake River from the south and west are the Bruneau, Owyhee, Malheur, Burnt, and Powder Rivers. The natural runoff of these rivers is erratic, making it necessary to have reservoirs capable of holding storage water over from one year to the next for a

dependable water supply. In the Owyhee, Malheur, Burnt, and Powder River basins where this type of holdover storage exists, most lands served from storage have adequate water supplies. On the upper reaches of the rivers above the reservoirs and on the small side streams, there are late-season water shortages every year. In these upper areas, the irrigated lands are used for pasture and forage crops. On the Vale Reclamation Project in the Malheur River drainage, on the Owyhee Reclamation Project, and on other lower lying areas, water supplies are generally adequate and the irrigated lands are used for alfalfa and rowcrops.

(3) North and east side tributaries. The major tributaries of the Snake River from the north and east are the Boise, Payette, and Weiser Rivers. The Boise River valley has a highly developed, adequately supplied irrigation network. The natural flow of the Boise River, supplemented by about a million acre-feet of storage, serves about a third of a million acres in Idaho and a small area in Oregon. An average of about 5 acre-feet per acre is delivered annually and there are no significant water shortages except in the driest years.

Nearly 150,000 acres are now irrigated in the Payette basin; about 120,000 acres are adequately supplied. Many of these lands are served from storage. In this basin, diversion rates are about 6.5 acre-feet per acre. However, there is much reuse of return flow.

The Weiser River basin contains a number of small drainages with narrow strips of farmland near the streams. In the upper reaches of these tributaries, large diversions are made when streamflows are available; the return flows from this irrigation are subsequently used downstream. The small storage reservoirs in the basin are insufficient to meet all irrigation requirements. Furthermore, because of their location, some lands cannot be served from the existing reservoirs.

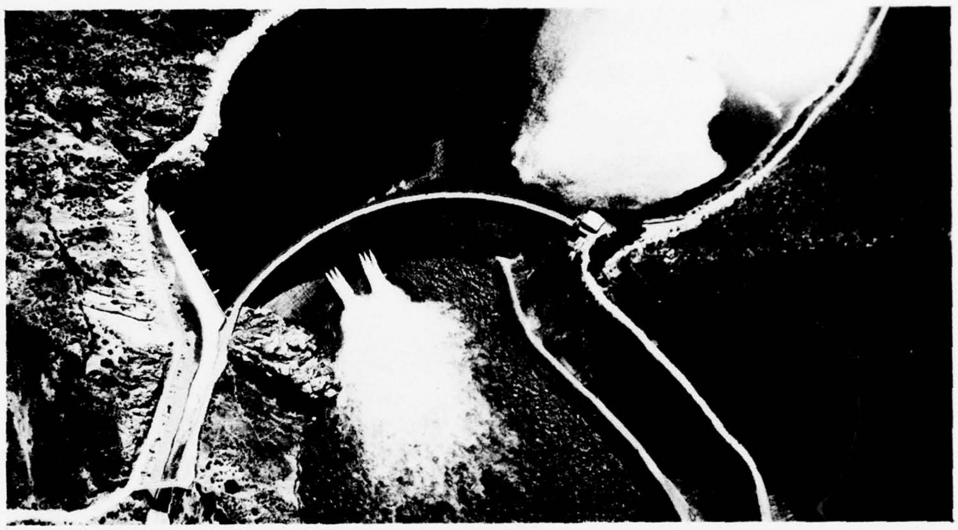
Ground water is used on about 6 percent of the irrigated lands in these north and east side tributary basins. Use of water in these areas varies from 3.0 acre-feet per acre where pumps are situated directly on the irrigated land to over 4.0 acre-feet per acre where distribution systems are involved.

Irrigation return flows in Subregion 5 are estimated to total nearly 3.4 million acre-feet annually (table 79). Return flow is used to some degree throughout the subregion; where water is pumped from the Snake River, part of that supply is return flow. Surface return flows vary in the different basins; for example, Boise River return flows have been estimated at 22 percent of diversion, Payette River return flows at 25 percent, and Burnt River return flows at 40 percent.

The average annual depletion of the subregion's water supply due to irrigation is estimated to be almost 3 million acre-feet. Approximately 90 percent of the total is consumed beneficially in crop production, with the remainder being consumed nonbeneficially on and adjacent to the irrigated lands.

## Adequacy of Supply

The natural flows of nearly all the Snake River's tributaries in Subregion 5 are overappropriated. Enough storage reservoirs have been built on the Boise, Payette, Owyhee, and Malheur Rivers to provide adequate irrigation water to the lands with storage supplies. All lands served from ground water are also believed to have adequate supplies.



*Since its completion more than 50 years ago, Arrowrock Dam has been a key facility of the Boise Project. (Bureau of Reclamation)*

An estimated 393,000 acres in the subregion now experience irrigation water shortages, including principally the following areas: all Nevada lands, Owyhee River lands above Owyhee Reservoir; Malheur, Burnt, and Powder River lands without storage; North Fork Payette River lands; and upper Weiser River basin lands. These lands, shown on figure 27, have estimated average annual shortages totaling 504,000 acre-feet.

## Application of Water

Irrigation water is generally applied by gravity systems in the Central Snake Subregion, and all the usual methods of gravity applications are used including borders, corrugations, and flooding. Almost all the lands irrigated from the tributaries of the Snake River are served by gravity distribution systems.

Irrigation by sprinkler is increasing, especially where new lands are being developed for irrigation. The new lands are generally in large blocks and are supplied by pumping from streams or from ground water wells. The largest areas served by sprinkler are those now irrigated by high-lift pumping from the Snake River and from ground water. Since irrigation from these water sources frequently involves high pumping costs, the higher efficiencies gained under sprinkler application are important.

## Quality of Water

The water quality of Subregion 5 is generally good, with most analyses showing the waters to be well suited to irrigation. Annual precipitation in the subregion ranges from less than 10 inches in the southern part to 40 inches and over in the mountains of the northeast; the water quality of the tributary streams reflects these differences.

The water quality of the Snake River varies little from King Hill downstream to Weiser, the last irrigated area of any size along the main stem. The tributaries, however, show a large variance in chemical quality between the headwaters and the downstream areas. The Boise River, for example, shows a six-fold increase in dissolved solids from approximately 40 parts per million near the head of the Boise Valley to over 240 parts per million near the river's mouth. This is also true on the south and west side tributaries, indicating quality alteration due to man's activities, including irrigation. Even with the increase in mineralization, however, most waters are well suited for irrigation.

# FUTURE NEEDS

Nearly a million acres of new irrigation development will be needed in Subregion 5 by 2020, an increase of 68 percent over the presently irrigated acreage. These future requirements can be met by furnishing additional water for irrigated lands now having less than a full supply and by the development of new irrigated areas. The subregion contains over 5 million acres presently nonirrigated which are physically suited to irrigation. Of the 1,465,000 acres irrigated in 1966, some 393,000 acres are in need of supplemental supplies.

## Lands

Projected food and fiber requirements and projected crop yields were given primary consideration in identifying future irrigated acreage needs. In addition, the availability of land and water, anticipated state, Federal, and private developments and political and social factors were considered to varying degrees.

Satisfaction of future needs under the assumed conditions will require an expansion in irrigated acreage from 1,465,000 acres in 1966 to 1,950,000 acres by 1980, to 2,120,000 by year 2000, and 2,460,000 acres by 2020. These projected needs were built up from harvested cropland and pasture with adjustments to include irrigated lands not used directly in crop and pasture production. The total irrigated acreage needs are presented in table 80.

Table 80 - Irrigated Area Needs by 1980, 2000, and 2020
Subregion 5

| Item | Irrigated Acreage 1980 | 2000 | 2020 |
|---|---|---|---|
| | (1,000's) | | |
| Harvested cropland and pasture 1/ | 1,521 | 1,658 | 1,935 |
| Other 2/ | 429 | 462 | 525 |
| Total irrigated area | 1,950 | 2,120 | 2,460 |

1/ From table 81.
2/ Includes irrigated forest, range, rights-of-way, ditches, roadways, farmsteads, urban, and idle irrigated lands not used in the production of projected crop requirements.

Agriculturally productive irrigated lands which consist of irrigated cropland harvested and pasture are presented by crop categories in table 81.

Small grain acreage needs are projected to decrease while significant increases are projected for hay and pasture. The reduction in small grain acreage needs results from the fact that small grain yields are projected to increase at a faster rate than production requirements. Fairly constant fruit acreage projections also result from high yield projections. Sugar beet acreage needs are projected to increase considerably. This is in line with the increasing capacity of the local processing industry.

Table 81 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020 Subregion 5

| Crop Category | Acreage Needs 1/ 1980 | 2000 (1,000's) | 2020 |
|---|---|---|---|
| Small grains | 336 | 307 | 280 |
| All hay | 441 | 499 | 611 |
| Dry beans and peas | 5 | 6 | 7 |
| Sugar beets | 94 | 136 | 191 |
| Potatoes | 56 | 63 | 78 |
| Vegetables | 17 | 19 | 20 |
| Fruits, nuts, and berries | 13 | 13 | 14 |
| Forage seed, hops, and mint | 104 | 108 | 125 |
| Pasture | 315 | 355 | 431 |
| Unenumerated | 140 | 152 | 178 |
| Total | 1,521 | 1,658 | 1,935 |

1/ Includes only needs within economic subregion.

## Production and Yield

Projected crop production from irrigated land is presented in table 82. This is followed by projected yields in index form on figure 29. The yield indexes for each crop category indicate the percentage increase in yield projected from 1964 as a base year. Acreage needs were determined as a result of the production requirements and yields. Changes in either from what has been projected would result in changes in acreage needs.

Table 82 - Crop Production from Projected Irrigated Acreage for 1980, 2000, and 2020, Subregion 5

| Crop Category | Units | Production 1980 | 2000 (1,000's) | 2020 |
|---|---|---|---|---|
| Small grain | tons | 751 | 857 | 950 |
| Hay | tons | 1,599 | 2,196 | 3,161 |
| Dry beans and peas | cwt. | 119 | 177 | 247 |
| Sugar beets | tons | 2,777 | 4,375 | 6,550 |
| Potatoes | cwt. | 22,554 | 30,523 | 42,797 |
| Vegetables | cwt. | 5,386 | 6,588 | 8,644 |
| Fruits, nuts, and berries | tons | 73 | 105 | 152 |
| Forage seed, hops, and mint | lbs. | 35,760 | 47,153 | 69,114 |

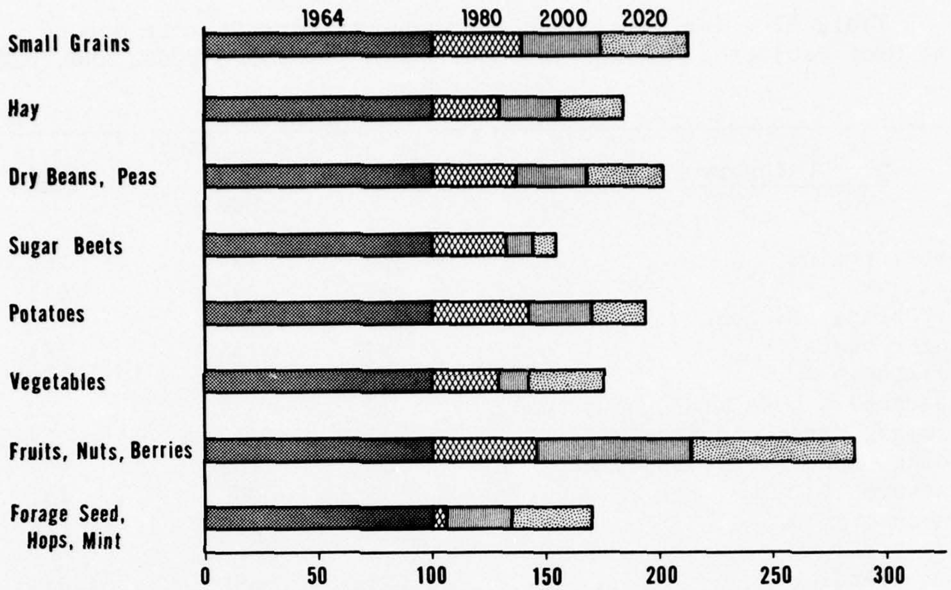



FIGURE 29. Projected Crop Yields in 1980, 2000, and 2020 for Selected Crops (1964 as Base Year Equals 100), Subregion 5.

Value of Production

Values of projected irrigated crop production are presented in table 83. The values are based on projected production and the

Table 83 - Value of Projected Irrigated Crop Production, Subregion 5

| Crop Category | Value of Production 1/ 1980 | 2000 ($1,000) | 2020 |
|---|---|---|---|
| Small grains | 39,700 | 45,300 | 50,200 |
| Hay | 34,400 | 47,200 | 68,000 |
| Dry beans and peas | 600 | 900 | 1,300 |
| Sugar beets | 31,900 | 50,300 | 75,300 |
| Potatoes | 30,200 | 40,900 | 57,300 |
| Vegetables | 16,000 | 19,600 | 25,700 |
| Fruits, nuts, and berries | 8,800 | 12,700 | 18,400 |
| Forage seed, hops, and mint | 7,400 | 9,800 | 14,400 |
| Total | 169,000 | 226,700 | 310,600 |

1/ Based on projected normalized prices.

same price structure as used by the Office of Business Economics and the Economic Research Service in the regional projection. Crops normally fed to livestock with the exception of pasture are included.

## Water

The total irrigation water requirement of Subregion 5 includes the amount of water needed to relieve the shortages on presently irrigated lands and the amount required to provide the full supply for dry lands which are expected to be irrigated. Meeting these needs will create additional farm deliveries of 3.7 million acre-feet and additional depletions of 2.7 million acre-feet in 2020. Estimated needs are shown by time periods in table 84.

Table 84 - Projected Farm Deliveries and Depletions
Subregion 5

| | Presently Irrigated | | Future Irrigation | | Total | |
|---|---|---|---|---|---|---|
| Year | Farm Delivery | Depletion | Farm Delivery | Depletion | Farm Delivery | Depletion |
| | | | (1,000 acre-feet) | | | |
| 1966 | 4,390 | 2,975 | -- | -- | 4,390 | 2,975 |
| 1980 | 4,750 | 3,240 | 1,600 | 1,210 | 6,350 | 4,450 |
| 2000 | 4,750 | 3,240 | 2,180 | 1,630 | 6,930 | 4,870 |
| 2020 | 4,750 | 3,240 | 3,320 | 2,460 | 8,070 | 5,700 |

### Supplemental

To fully supply the inadequately irrigated lands in Subregion 5, an additional annual diversion supply of 504,000 acre-feet needs to be developed. This amount of diversion will produce increased farm deliveries of 360,000 acre-feet annually and depletions of 265,000 acre-feet annually. The annual need by tributary basin is shown in table 85.

### Full

A large portion of Subregion 5 is a continuation of the Snake River Plateau that slopes downward from Subregion 4. Lands are generally lower in elevation and water requirements are larger as distance downstream along the Snake River increases.

Table 85 - Supplemental Irrigation Diversion Requirements, Subregion 5

| River Basin | Water-Short Lands (acres) | Supplemental Requirement (acre-feet) |
|---|---|---|
| Snake River, main stem | | |
| Minor north side tributaries | 8,800 | 12,000 |
| Minor south side tributaries | 10,000 | 13,000 |
| Subtotal | (18,800) | (25,000) |
| South and west side tributaries | | |
| Bruneau | 11,200 | 15,000 |
| Owyhee | 162,400 | 240,000 |
| Malheur | 36,600 | 49,000 |
| Burnt | 10,900 | 11,000 |
| Powder | 104,300 | 109,000 |
| Other | 10,000 | 11,000 |
| Subtotal | (335,400) | (435,000) |
| North and east side tributaries | | |
| Payette | 28,000 | 31,000 |
| Weiser | 10,800 | 13,000 |
| Subtotal | (38,800) | (44,000) |
| Total | 393,000 | 504,000 |

Irrigation requirements in the tributary areas vary from basin to basin depending on the proportion of land expected to be irrigated at high and low elevations. The Weiser, Malheur, and lower Owyhee basins have a high proportion of lands at low elevation with resulting high requirements. The Payette, Burnt, and Powder River basins and the Owyhee high desert lands have more lands at high elevation and therefore have lower requirements. Estimated unit farm delivery requirements and depletions are shown in table 86.

Table 86 - Irrigation Requirements and Use
Subregion 5

| Area | Present - 2000 Farm Delivery (AF/ac.) | Present - 2000 Depletion (AF/ac.) | 2000 - 2020 Farm Delivery (AF/ac.) | 2000 - 2020 Depletion (AF/ac.) |
|---|---|---|---|---|
| Snake River main stem | | | | |
| a) King Hill to Weiser (includes Bruneau & Mt. Home plateaus | 3.3 | 2.5 | 3.4 | 2.5 |
| b) Weiser to Oxbow | 4.0 | 2.9 | 3.7 | 2.7 |
| South & west side tributaries | | | | |
| a) Owyhee River basin | | | | |
| High desert | 3.6 | 2.5 | 2.8 | 2.1 |
| Low lands | 3.3 | 2.5 | 3.7 | 2.7 |
| b) Malheur River basin | 3.3 | 2.5 | 3.4 | 2.5 |
| c) Burnt River basin | 2.8 | 2.1 | 2.9 | 2.2 |
| d) Powder River basin | 2.3 | 1.8 | 2.8 | 2.1 |
| North & east side tributaries | | | | |
| a) Boise River basin | 3.1 | 2.2 | 3.1 | 2.3 |
| b) Payette River basin | 3.6 | 2.5 | 2.8 | 2.1 |
| c) Weiser River basin | 4.0 | 2.8 | 3.4 | 2.5 |

## THE POTENTIAL TO MEET THE NEEDS

Subregion 5 does not have enough water originating within the subregion to supply all its potentially irrigable lands. However, there is more than enough to satisfy the projected 2.7 million acre-foot increase in depletions needed by year 2020. This amount is needed to irrigate nearly a million acres of new land and provide a full water supply to the 393,000 acres presently experiencing water shortages. On an average annual basis, 6.2 million acre-feet of water now flows into the subregion at King Hill, and 11.8 million acre-feet flows out at Oxbow. Thus 5.6 million acre-feet is available from supplies originating in the subregion.

### Potentially Irrigable Lands

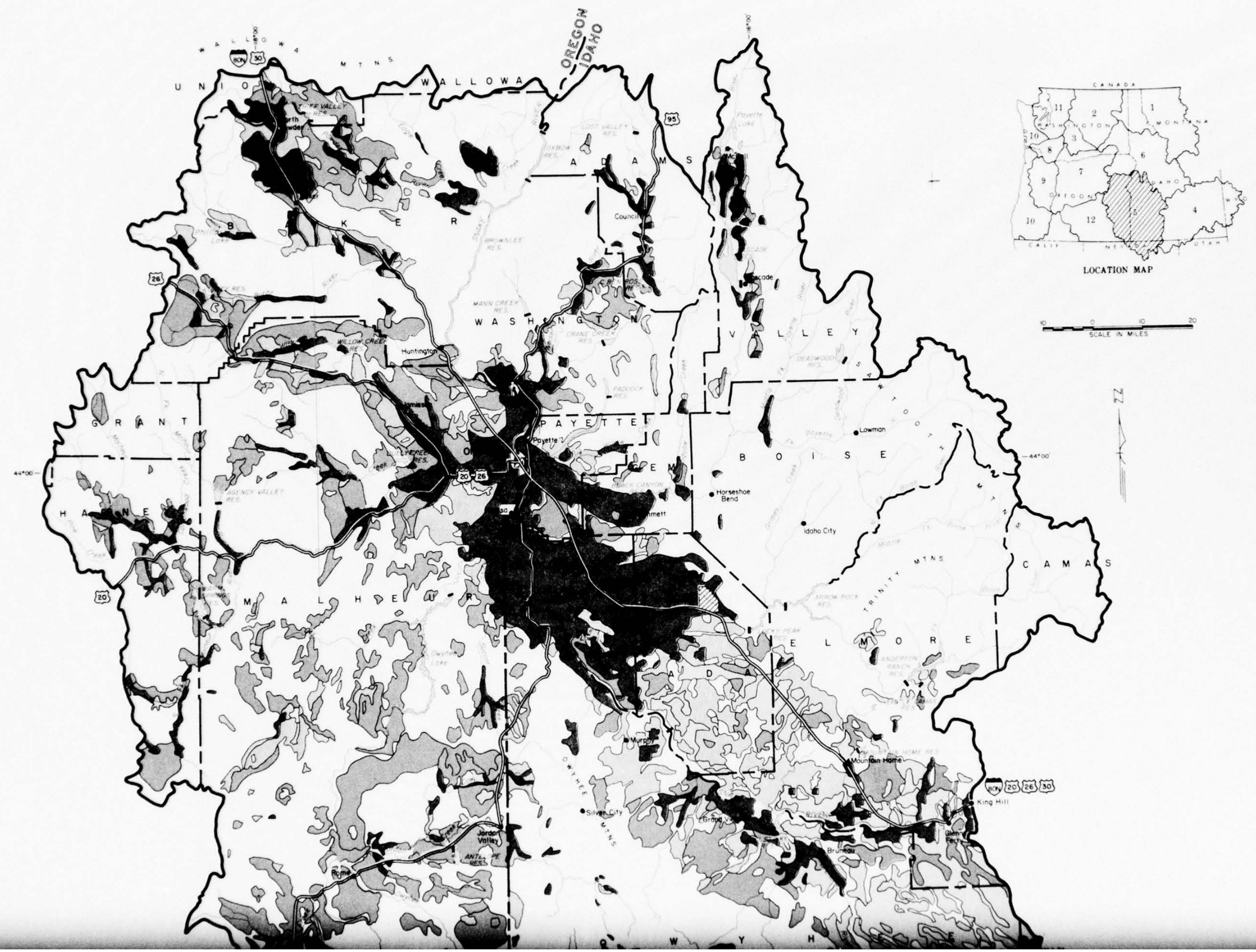
Based on specifications developed for the Columbia-North Pacific study, 4,321,600 acres have been identified as potentially irrigable and placed in three irrigability classes. These lands are suitable for agricultural purposes although in some cases they may have a greater potential for nonagricultural purposes. An additional 734,500 acres are in an "Other" category. Under irrigation they would be primarily suited to producing limited forage for wildlife and livestock grazing.

A large acreage of high quality lands remains available for irrigation; 37 percent of the classified lands were placed in classes 1 and 2 for more intensive irrigation uses. The location of the classified lands is shown on figure 30. Table 87 presents the results of the classification.

Table 87 - Potentially Irrigable Lands, Subregion 5

| State | Class 1 | Class 2 | Class 3 | Subtotal | Other | Total |
|---|---|---|---|---|---|---|
| | | | (acres) | | | |
| Idaho | 352,300 | 1,035,600 | 949,900 | 2,337,800 | 237,000 | 2,574,800 |
| Oregon | 100,400 | 308,000 | 1,073,200 | 1,481,600 | 448,000 | 1,929,600 |
| Nevada | 10,500 | 99,600 | 392,100 | 502,200 | 49,500 | 551,700 |
| Total | 463,200 | 1,443,200 | 2,415,200 | 4,321,600 | 734,500 | 5,056,100 |
| Percent | 9 | 28 | 48 | 85 | 15 | 100 |
| Subarea | | | | | | |
| Mountain Home Plateau | 154,700 | 320,400 | 102,800 | 577,900 | - | 577,900 |
| Bruneau Plateau | 153,400 | 503,800 | 483,200 | 1,140,400 | 99,700 | 1,240,100 |
| Payette R. Basin | 19,100 | 59,400 | 48,900 | 127,400 | - | 127,400 |
| Boise R. Basin | 17,300 | 29,300 | 27,200 | 73,800 | 16,800 | 90,600 |
| Weiser R. Basin | 4,600 | 40,600 | 54,000 | 99,200 | - | 99,200 |
| Owyhee R. Basin | 62,100 | 263,300 | 1,291,000 | 1,616,400 | 408,200 | 2,024,600 |
| Malheur R. Basin | 39,300 | 107,600 | 321,100 | 468,000 | 97,000 | 565,000 |
| Burnt & Powder R. Basins | 12,700 | 118,800 | 87,000 | 218,500 | 112,800 | 331,300 |
| TOTALS | 463,200 | 1,443,200 | 2,415,200 | 4,321,600 | 734,500 | 5,056,100 |

Over half (51 percent) of the potentially irrigable lands are located in Idaho, 38 percent in Oregon, and 11 percent in Nevada. Three-fourths of the higher quality (classes 1 and 2) lands are located in Idaho. The largest area of potentially irrigable


OREGON
IDAHO
WALLOWA MTNS
UNION
WALLOWA
BAKER
ADAMS
VALLEY
WASHINGTON
PAYETTE
GEM
BOISE
CAMAS
ELMORE
ADA
GRANT
HARNEY
MALHEUR
OWYHEE
SAWTOOTH MTNS
TRINITY MTNS
OWYHEE MTNS
Council
Cascade
Lowman
Idaho City
Horseshoe Bend
Emmett
Payette
Huntington
Murphy
Mountain Home
King Hill
Silver City
Grand View
Bruneau
Jordan Valley
Rome
LOST VALLEY RES.
OXBOW RES.
BROWNLEE RES.
MANN CREEK RES.
CRANE CREEK RES.
PADDOCK RES.
DEADWOOD RES.
ARROW ROCK RES.
ANDERSON RANCH RES.
LUCKY PEAK RES.
MOUNTAIN HOME RES.
AGENCY VALLEY RES.
WILLOW CREEK RES.
ANTELOPE RES.
Payette Lake
Owyhee Lake
Phillips Lake
44°00'
LOCATION MAP
CANADA
WASHINGTON
MONTANA
OREGON
IDAHO
CALIF
NEV
UTAH
WYO
1
2
3
4
5
6
7
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SCALE IN MILES
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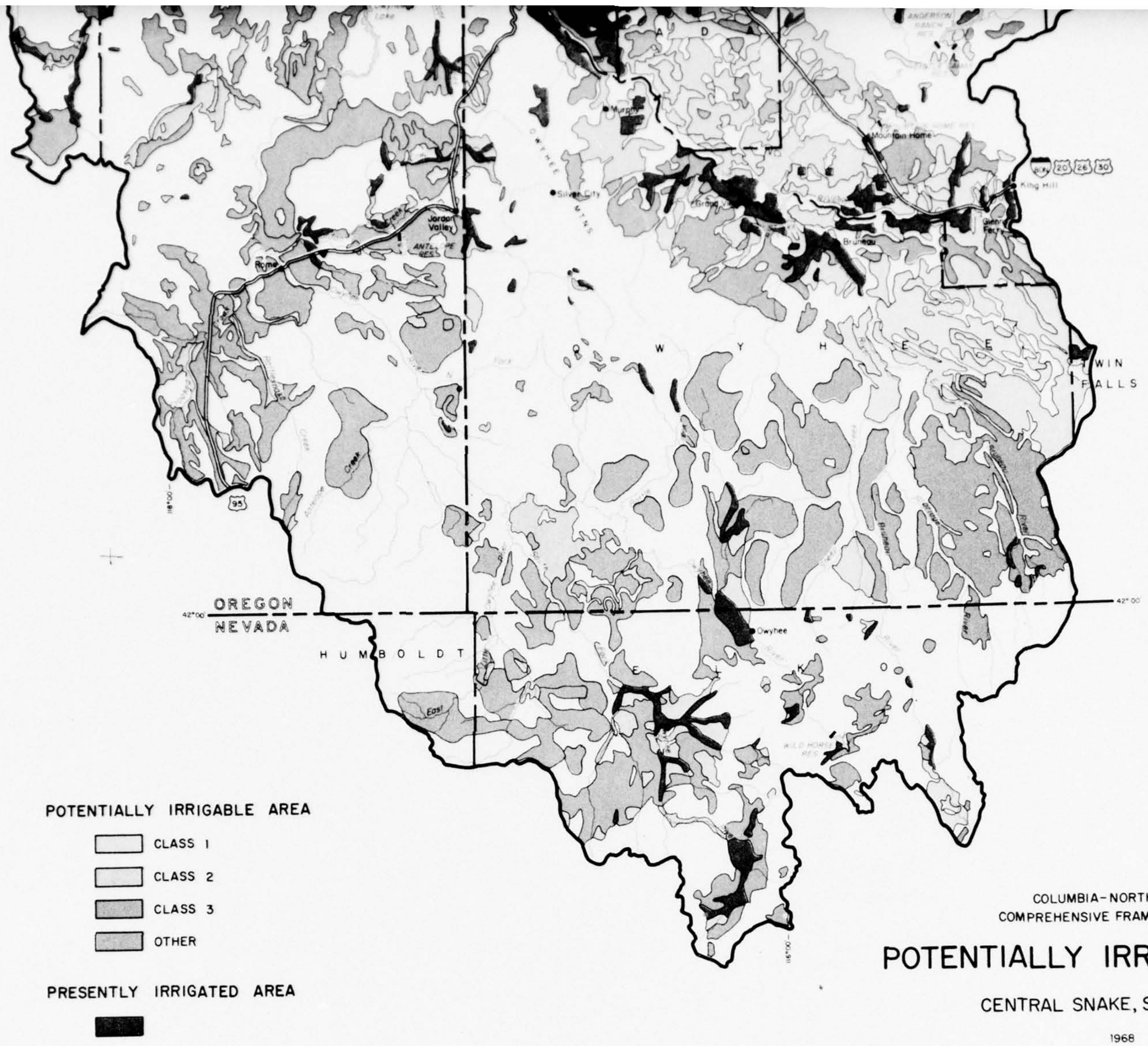



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# POTENTIALLY IRRIGABLE AREA

CENTRAL SNAKE, SUBREGION 5

1968

FIGURE 30

2

land is located on the Snake River Plateau and extends from the eastern border of the subregion west to the present irrigation in the Boise Valley. These are the lands of the Mountain Home Plateau (north of the Snake River) and the Bruneau Plateau (south of the river).

Elevations of these lands range from about 2000 feet on the Snake River Plateau to over 5000 feet in the mountain valleys scattered throughout the subregion. Crop adaptability varies according to elevation. The growing seasons vary from more than 180 days at the lower elevations to 100 days or less at the higher elevations.

The subregion's soils have developed from recent windlaid, lakebed, alluvial, and glacial materials. Some soils show pronounced profile development, with fine-textured, strongly developed "B" horizons being common. The "B" horizon is the zone in the soil profile which has accumulated materials leached from the topsoil. Slick spots, small areas that become slick when wet because of excess concentrations of sodium or alkali, are common in some areas. The permeability of these fine-textured soils is generally low, and without some corrective measures plant growth is restricted. Deep plowing to modify the soil profile can in many cases improve soils with restrictive "B" horizons.

## Class 1

Class 1 lands total 463,200 acres, 9 percent of the potentially irrigable acreage. Most of the class 1 lands are in Idaho's Owyhee, Elmore, and Ada Counties, with the remainder scattered throughout the subregion in small bodies, usually as alluvial bottom lands. These are the best lands classified; most are at elevations of less than 3500 feet and have growing seasons of more than 130 days. These lands when irrigated are capable of producing yields equal to those on the best quality lands now being irrigated in similarly climated areas of the subregion.

Soil textures are generally fine sandy loams and silt loams. The permeability and the water-holding capacity of the soils are good, and the soils are neutral or moderately alkaline. Some class 1 lands have slick spots, with less than 10 percent of the area affected. The topography of the class 1 lands is slightly undulating to gently rolling and the lands are well drained.

## Class 2

Class 2 lands total 1,443,200 acres, 28 percent of the potentially irrigable acreage. Most of the class 2 lands are

intermingled with the class 1 lands on the Mountain Home and Bruneau Plateaus. These lands are of good quality for irrigation and would produce well under irrigation.

Soil textures are mostly silt loams, but range from fine sandy loams to clay loams. The soils are permeable and have good water-holding capacities. High water table levels are generally not a problem; however, lands which under irrigation would have drainage problems could be drained at a moderate cost.

Some of the class 2 lands have slick spots, with less than 25 percent of the area affected. Well-developed "B" horizons ranging in texture from loams to light clay loams are common in the soil profiles of some of these lands. Caliche, a type of hardpan, may be found as shallow as 20 inches, but it is not continuous over any wide area and is generally fractured and broken. Some areas contain enough surface rock to require clearing.

## Class 3

Class 3 lands total 2,415,200 acres, 48 percent of the potentially irrigable acreage. These lands are best suited for the production of pasture, small grains, or forage crops. Most of the class 3 lands lie above 3000 feet in elevation and are scattered throughout the subregion, with the largest blocks in the Bruneau and Owyhee uplands.

Soil textures of the class 3 lands range from loamy sands to clays; surface soils are usually silt loams and clay loams. Fine-textured "B" horizons with strong, well-developed structures and very slow permeability are common. Soils range from moderately acid to moderately alkaline. Shallowness to gravel and caliche and stoniness of the surface soil are common deficiencies of these lands.

The topography of most of the class 3 land is quite rolling, and slopes up to 20 percent are common. Natural drainageways provide ample surface drainage, but the internal drainage of much of this land is poor.

## Other

In addition to the lands included in the classification, 734,500 acres have been identified as having a long-range potential for range forage production and wildlife habitat improvement under irrigation. Although these lands do not generally meet the minimum criteria for class 3 lands, they are identified to show the ultimate potential in the subregion.

## Water Supply

Estimated annual inflow to Subregion 5 is about 6 million acre-feet and outflow is 12 million acre-feet. Thus the Snake River shows a gain in flow of about 6 million acre-feet as it passes through the subregion. This gain includes present depletions of almost 3 million acre-feet within the subregion.

Approximately 100 million acre-feet of water are stored in the uppermost 50 to 100 feet of the ground water aquifer. Total gross annual recharge and discharge is estimated to be about 5 million acre-feet. Net annual recharge is estimated at 4 million acre-feet because of recycling of surface and ground water.

## Potential Development

Table 87 presents a breakdown of the potentially irrigable lands by subarea. Figure 26 shows the location of the subareas.

### Developments by Subarea

As shown in table 87, each area has a substantial amount of potentially irrigable lands. On the following pages is a brief description of each subarea's potential regarding both lands and water.

Mountain Home Plateau More than a half million acres of potentially irrigable lands are located on the Mountain Home Plateau north of the Snake River and south of the Boise Valley. Nearly all of the plateau lies at elevations ranging between 500 and 1000 feet above the Snake River.

Little surface water is available on the plateau itself, but enough water is now available in the Snake River to irrigate the area. A part of the plateau could also be irrigated by use of excess flows from the Boise and Payette Rivers. Regardless of the source, however, delivery of substantial amounts of surface water to the Mountain Home area will require extensive construction of storage and other facilities, complicated distribution systems, and high pump lifts from the Snake River.

A small amount of ground water has been developed for irrigation on the plateau, but widespread availability of ground water has not been verified. The delivery of large amounts of surface water into the area may permit the further development of a substantial ground water resource as a companion supply. However, this would depend on the potential for storage of deep percolation losses in the underlying aquifer.

Bruneau Plateau The Bruneau Plateau, with more than 1 million acres of potentially irrigable land, lies south of the Snake River in Idaho. Elevations vary from 500 to more than 2000 feet above the Snake River, somewhat higher than the lands of the Mountain Home Plateau. However, more than 400,000 acres of these lands are less than 600 feet above the Snake River.

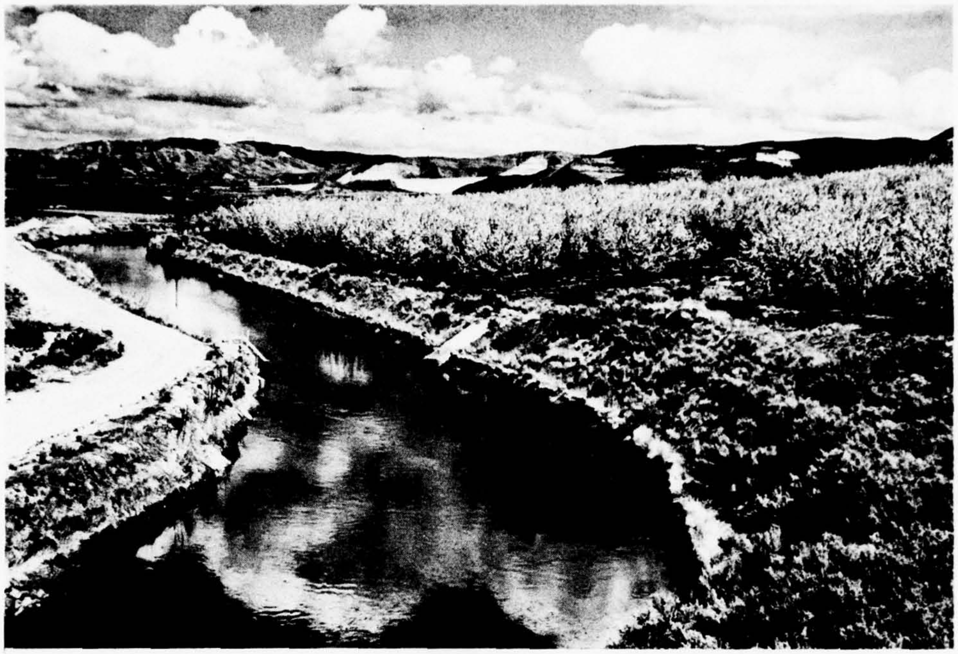
The Bruneau River, largest stream crossing the area, is not a likely source of water because of its relatively small available supply, its entrenchment in a deep and narrow canyon, and its proposed designation as a wild river. Because the other local streams contribute only small amounts of usable runoff, the most likely source of irrigation water is the Snake River. To irrigate any sizable acreage would require considerable storage space either on the Snake River or as offstream storage on the plateau.

Development of large quantities of ground water for irrigation is uncertain because it is known that in certain parts of the area the ground water is hot or is of questionable quality.

Payette River Basin The Payette basin contains nearly 130,000 acres of potentially irrigable land with more than enough water in the Payette River to irrigate it. Much of the potentially irrigable land, however, is located in the tributary areas of the basin where streamflows need storage regulation to be dependable for irrigation use. Because of the general abundance of surface water, ground water is not considered a likely source for irrigation in this basin.

Boise River Basin The already highly developed Boise River basin has only about 90,000 acres of potentially irrigable dry land remaining to be irrigated. Some of these lands, possibly as much as 60,000 to 70,000 acres in the Willow Creek area between Boise and Ontario, could be served from either the Boise or Payette River. The Payette River is the more likely source because of the high level of existing use of Boise River streamflows. Other lands can be served by pumping water from the Snake River, either directly to the new lands or through exchange for Boise River water now used on lands that could be served from the Snake. The opportunities for further development in the Boise River basin, other than the Willow Creek area and areas adjacent to and above the existing Boise Project canals, are minor.

Weiser River Basin Nearly 100,000 acres of potentially irrigable land lie within the Weiser River basin. The available water supply is limited, however, and new storage will be required for future development. Though several storage sites have been identified, the sites on Weiser River tributaries are generally



*Irrigated orchards, such as this one in the lower Payette River valley, produce apples, plums, cherries, and other fruits. (Bureau of Reclamation)*

small and costly. Main stem Weiser River storage will be expensive because of high right-of-way and relocation costs. Ground water is also available in this basin in moderate quantities but would be expensive for widespread irrigation use.

Owyhee River Basin The Owyhee River basin includes more than 2 million acres of potentially irrigable land. The Owyhee River is the most readily accessible source of water, but it is already nearly fully used to irrigate some 260,000 acres. Numerous existing small reservoirs on Owyhee River tributaries now store much of the headwater runoff of this river for downstream use. An example is Wild Horse Reservoir on the East Fork Owyhee River in Nevada. In the lower part of the basin, Owyhee Reservoir regulates the river except for occasional high floodflows. Because of the present high degree of regulation, increased use of the river would require new storage at locations convenient to the irrigated lands and provision for replacement from some other source (such as the Snake River) to compensate for the use of presently committed supplies.

Irrigation of new lands in the upper Owyhee River basin will most likely be limited by the lack of local water supplies.

Importation of water from the Snake River or any other source does not appear probable due to the remoteness of much of the Owyhee basin land area.

Permeability of the subsurface geologic formations is highly variable. Under certain conditions, moderate yields of ground water for irrigation could be expected. Intensive local investigation would be necessary, however, before the availability of a dependable supply could be assured.

Malheur River Basin The Malheur River basin is extensively irrigated, with over 190,000 acres receiving water; about 20 percent are considered to have an inadequate supply. The only undeveloped surface water supply in the Malheur basin is from infrequent floods and limited reservoir spills. Any substantial development of the 565,000 acres of potentially irrigable land must therefore be accomplished with water from other sources. Since a large portion of the potential land is located in the vicinity of the Snake River, pumping from this source is a possibility for future development. Ground water is also a potential source since moderate to large quantities at reasonable depths are available in the lower valley areas.

Burnt and Powder River Basins The Burnt and Powder River basins contain more than 330,000 acres of potentially irrigable lands. Only a minor portion of these lands could be irrigated with the existing surface water supply since about 70 percent of the lands already irrigated in these basins have substantial water shortages. Supplemental water for the irrigated lands and full supplies for a moderate acreage of dry lands could be provided through construction of more storage. Some ground water probably could be developed for new irrigation in these basins, but pumping in the Baker Valley would have to be carefully planned so as not to interfere with the subirrigation practices in the lower area.

## Private Developments

Privately owned irrigable lands and large blocks of Federally owned potentially irrigable lands are located throughout the subregion. Many of these lands are being actively considered for irrigation by private interests. At the present time the Federal Government has about 400 applications pending which if granted would permit the development of over 100,000 acres of new irrigated land. Within this group of applications are three community proposals--Bell Rapids, Green Valley, and Grindstone Butte--that would irrigate over 40,000 acres of new land.

An optimistic outlook for the future would be for this type of development to continue at or near the current pace.

A large part of the newly irrigated lands, however, have used unregulated surface flows of the Snake River, and the time is not far distant when seasonal flows will not be sufficient to continue this practice. It will be necessary in the future, therefore, to develop additional storage facilities in order to increase or maintain the rate at which new lands are irrigated.

## State Developments

The State of Idaho has the responsibility of participating and assisting in the development and utilization of its water and related land resources. Most of the foreseeable irrigation potential, whether developed by private interests, the state, or Federal agencies, will require storage. The development of storage and small projects could readily be accomplished either by the state or as a joint effort with Federal agencies or private enterprise. Currently the Idaho Water Resource Board is studying small projects that may be developed with state financing, such as the Canyon View proposal.

## Federal Developments

Both Federal and state developments will have to be coordinated with private initiative to meet the long range irrigation needs in the subregion. At the present time, investigations completed or scheduled by Federal agencies include plans for multiple-purpose projects which could irrigate 600,000 acres of new land and provide a supplemental water supply for another 300,000 acres. Active storage required for these developments is about 4 million acre-feet. In addition to providing a water supply for irrigation, the projects also provide power, flood control, fish and wildlife, and recreation benefits.

Storage sites have been identified on several streams, but the most significant in terms of the amount of space developed would be on the South Fork of the Payette River at the Garden Valley site and on the Owyhee River at the Duncan Ferry or Three Forks site. On a few tributaries, small amounts of land could be irrigated by storage and use of annual flood discharges which now are wasted. In potential developments where water deliveries will be required from overappropriated tributary streams, provisions will be necessary for replacement of supplies already committed.

LOCATION MAP

# SUBREGION 6

# SUBREGION 6

# LOWER SNAKE

## THE SETTING

Portions of three states make up the area within Subregion 6. The subregion's 22.5 million acres, 13 percent of the regional total acreage, is distributed among Idaho, 70 percent; Washington, 16 percent; and Oregon, 14 percent.

The Lower Snake Subregion consists of the lower third of the Snake River basin; it includes the drainage areas of the Snake River and its tributaries from above Hells Canyon Dam downstream to the confluence of the Snake and Columbia Rivers. Major tributaries of the Snake River in this reach are the Clearwater and the Salmon Rivers in Idaho, the Palouse and Tucannon Rivers in Washington, and the Grande Ronde and Imnaha Rivers in Oregon.

Three subareas--the Imnaha and Grande Ronde River basins, the Palouse and Lower Snake River basins, and the Salmon and Clearwater River basins--have been developed to help with presentation of data. They are shown on figure 31.

The entire eastern portion of the subregion, including most of the Idaho lands, is in the Northern Rocky Mountain physiographic province. The northern portion is in the Walla Walla Plateau, the western portion in the Columbia Plateau, and the southern portion in the Blue Mountains physiographic province. A general indication of the ruggedness of the subregion is noted in the elevations which range from 340 feet to more than 12,000 feet above sea level.

Lands publicly owned comprise 65 percent of the subregion. Of these lands, 80 percent is forested and the remainder is predominately rangeland. About 39 percent of the privately owned lands is cropped, 23 percent is forest covered, and 33 percent is rangeland.

A wide range of climatic conditions is found in this subregion. The valleys at the upper end of the Salmon River drainage are at elevations of 5000 feet and over, while lands along the rivers at the lower end of the subregion are less than 1000 feet in elevation. Growing seasons range from over 200 days at the lower elevations to less than 100 days in the mountain valleys. Precipitation ranges from less than 10 inches annually near the mouth of the Snake River to much more at the higher elevations.

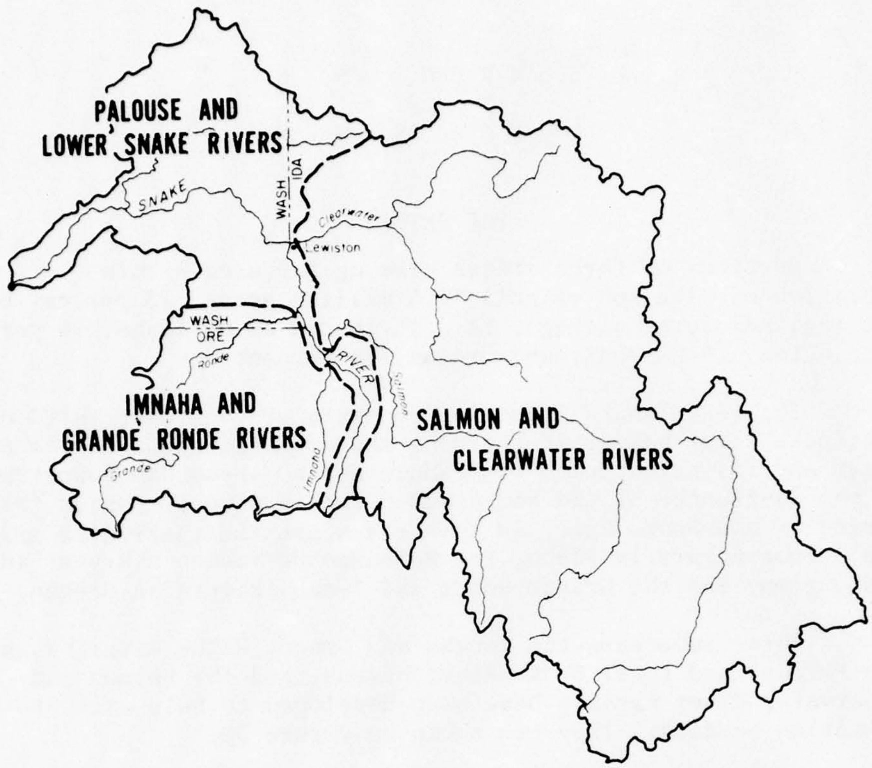



FIGURE 31. Subareas in Subregion 6, Lower Snake.

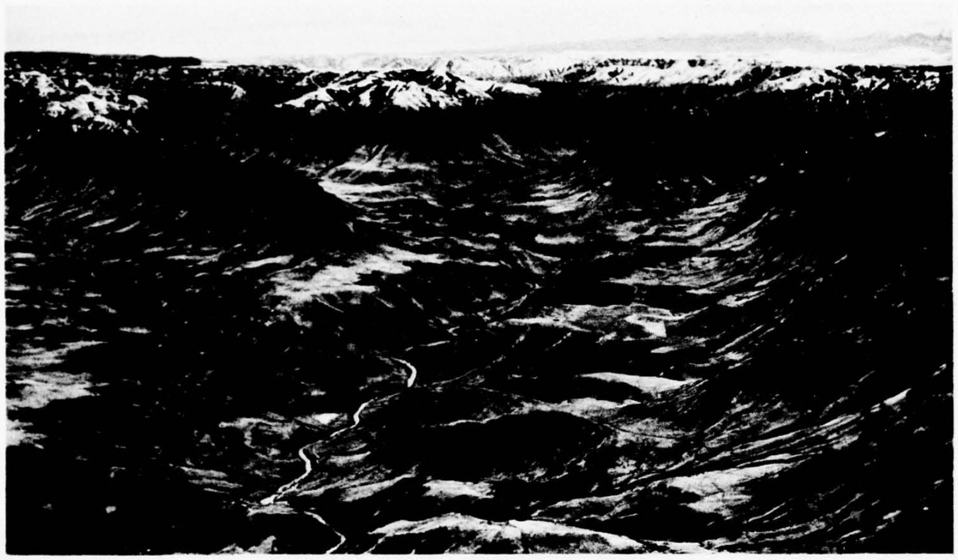
Exceptions are found in the valleys near the head of the Salmon River drainage; precipitation of only about 10 inches is common since these areas lie in the rain shadow of the mountains to the west.

Agriculture and forestry provide the major concentrations of employment. Employment in manufacturing is distributed among several industries with a primary emphasis on food processing and paper manufacturing.

About 4 people per square mile inhabit the subregion. The 1965 population was about 163,250; many live in the communities of Lewiston and Moscow, Idaho; Pullman and Clarkston, Washington; and LaGrande, Oregon.

The rugged terrain constricts the construction of transportation facilities in much of this subregion. Much of Idaho's famed Primitive Area, where no roads are allowed, is located in

the subregion. There are adequate north-south highway systems and highway and railroad outlets to the west. Limited navigation is available upstream to Lewiston on the Snake River. Commercial air service to the subregion's larger cities is also available.



*Much of the Lower Snake Subregion is rugged and mountainous; a good example is the lower Imnaha River drainage. (Bureau of Reclamation)*

Since the 1860's, irrigation agriculture has been established in several locations. Unsuccessful attempts to develop irrigation occurred here as early as the 1830's. When successful irrigation was established, it was often to support the subregion's important mining industry.

Nearly all the irrigation has been individual, privately financed development. Among the few project-type developments are the Lewiston Orchards Reclamation Project and two small portions of the Columbia Basin Reclamation Project. The Lewiston Orchards Project, located on a benchland adjacent to Lewiston, Idaho, was built by private interests in the early 1900's. After World War II, the project was enlarged and extensively rehabilitated by the Bureau of Reclamation to provide water to nearly 3,600 acres which produce fruit, vegetables, and other crops. Suburban development has now taken over a large portion of the project lands.

Some 4,300 acres in two blocks of the Columbia Basin Project are located in the lower end of the subregion near the mouth of the Snake River. Approximately 3,000 acres on the northern boundary

of the subregion are served water from Subregion 2. In addition, a 1,300-acre block of the project south of the Snake River is irrigated by pumping from the Snake River. See figure 32.

## PRESENT STATUS

In contrast to the Upper and Central Snake River Subregions, only a small fraction of the Lower Snake Subregion's farmland is irrigated. Little of the total water resource of the subregion is used for irrigation, and most of this use is from the tributaries of the Snake River.

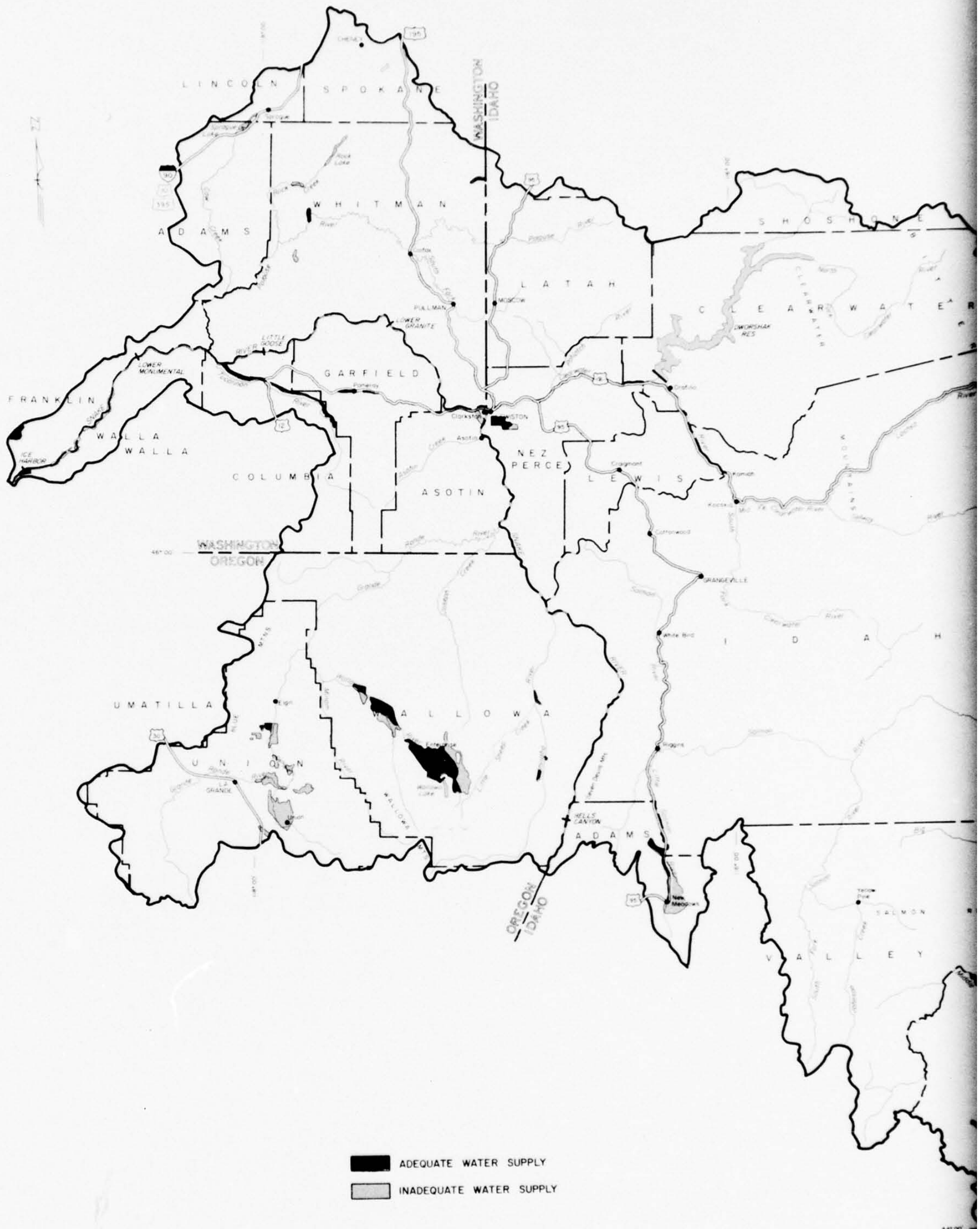
In 1966 276,000 acres were irrigated, according to studies made by the Soil Conservation Service and the Bureau of Reclamation. The irrigated acreages by source and adequacy of supply and method of irrigation are shown in table 88. Nearly all (96 percent) of the irrigated area in Subregion 6 is served from surface water sources; nearly half of this area has an inadequate water supply. Only 4 percent of the irrigated area is served from ground water sources; all of it is considered to be adequately supplied. Non-agricultural uses of irrigation water include 800 acres of forest seed orchards, recreation, and wildlife areas. Both ground water and surface water flows are utilized.

Table 88 - Irrigated Area, 1966, Subregion 6

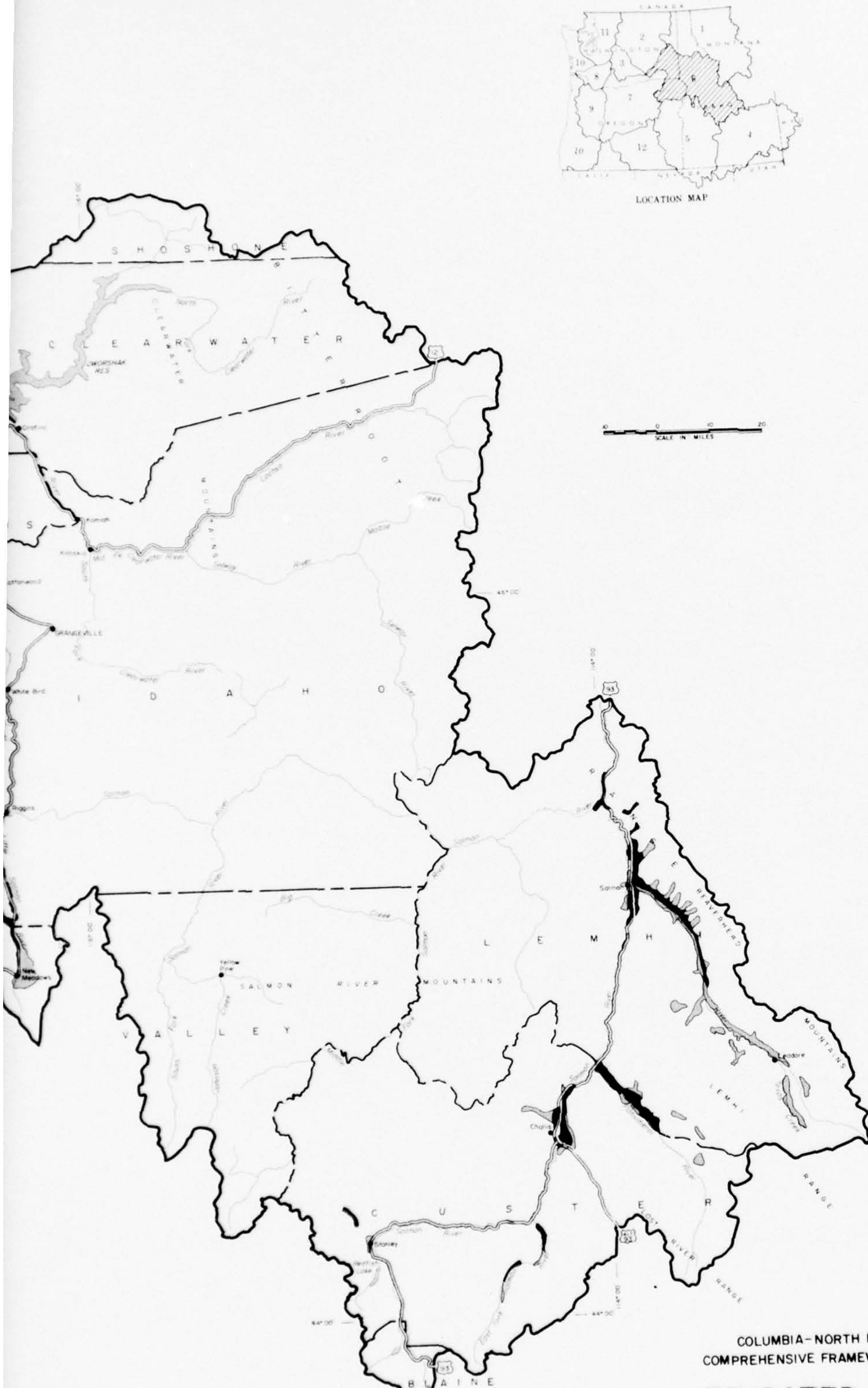
| | Surface Water | | Ground Water | | Method of Irrig. | | |
|---|---|---|---|---|---|---|---|
| State | Adeq. Supply | Inadeq. Supply | Adeq. Supply | Inadeq. Supply | Sprinkler | Gravity | Total |
| | | | | (acres) | | | |
| Idaho | 80,000 | 62,000 | 1,000 | -- | 8,000 | 135,000 | 143,000 |
| Oregon | 42,000 | 55,000 | 4,000 | -- | 24,000 | 77,000 | 101,000 |
| Washington | 16,000 | 10,000 | 6,000 | -- | 29,000 | 3,000 | 32,000 |
| Total | 138,000 | 127,000 | 11,000 | -- | 61,000 | 215,000 | 276,000 |

### Characteristics of Irrigated Areas

Although agriculture is a major factor in the subregion's economy, irrigation is of limited importance. As shown on figure 32, the subregion's irrigated areas are relatively small and widely scattered, with the largest areas located in the Pahsimeroi and Lemhi River valleys in Idaho and in the Grande Ronde and Wallowa River valleys in Oregon. Just over half



LINCOLN
SPOKANE
WASHINGTON
IDAHO
WHITMAN
ADAMS
LATAH
SHOSHONE
CLEARWATER
FRANKLIN
WALLA WALLA
LOWER MONUMENTAL
ICE HARBOR
LITTLE GOOSE
LOWER GRANITE
GARFIELD
COLUMBIA
ASOTIN
NEZ PERCE
LEWIS
DWORSHAK RES
GRANGEVILLE
WASHINGTON
OREGON
IDAHO
UMATILLA
UNION
WALLOWA
HELLS CANYON
ADAMS
OREGON
IDAHO
VALLEY
SALMON
ADEQUATE WATER SUPPLY
INADEQUATE WATER SUPPLY




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# IRRIGATED AREA

LOWER SNAKE, SUBREGION 6

1968

FIGURE 32

(52 percent) of the subregion's irrigated area is in Idaho, 37 percent is in Oregon, and the remaining 11 percent is in Washington.

Over half of the lands irrigated from ground water are in Washington, and most of the remainder are in Oregon, principally in the Grande Ronde Valley. Since the acreage irrigated from ground water is such a small part of the total irrigated acreage, ground water irrigation is not differentiated from surface-water irrigation on figure 32.

*Several large blocks of land are being irrigated in the Grande Ronde Valley near LaGrande, Oregon. (Bureau of Reclamation)*

Hay and pasture are produced on most of the irrigated lands, particularly in the high mountain valleys of Idaho. Other irrigated crops include grain, potatoes, asparagus, peas, and seed. The cropping patterns are most diversified on the lands along the lower reaches of the subregion's major streams.

Irrigation agriculture in the eastern portion of the subregion is generally limited to the production of pasture and a few short-season crops. A significant portion of the forage crops is grown under irrigation; over a fifth of the feed requirement of the livestock industry was produced under irrigation according to the 1964 Census of Agriculture. Though production is limited, most of the subregion's potatoes are grown under irrigation, and much of the vegetable and fruit production is from irrigated land.

The 1964 Census of Agriculture states that the economic study area contained 7,100 farms, of which only 1,800 were classified as irrigated. The economic study area includes the counties of Clearwater, Custer, Idaho, Latah, Lemhi, Lewis, and Nez Perce in Idaho; Asotin, Garfield, and Whitman in Washington; and Union and Wallowa in Oregon. Over two-fifths of all farms were classified as field-crop farms, of which almost all were the cash-grain operations located primarily in the Palouse area in Idaho and Washington. Livestock farms are also numerous in the subregion.

The total land area in the 1,800 irrigated farms was about 1.8 million acres with some 255,000 acres irrigated in 1964. Farm size averaged 1,000 acres, with an average of 140 acres irrigated.

Figure 33 shows the acreage of irrigated land for harvested cropland and pasture. As the chart shows, 84 percent of the irrigated land was used to produce forage and pasture, 10 percent was used for small grains, and only 6 percent was used to produce other crops and vegetables.

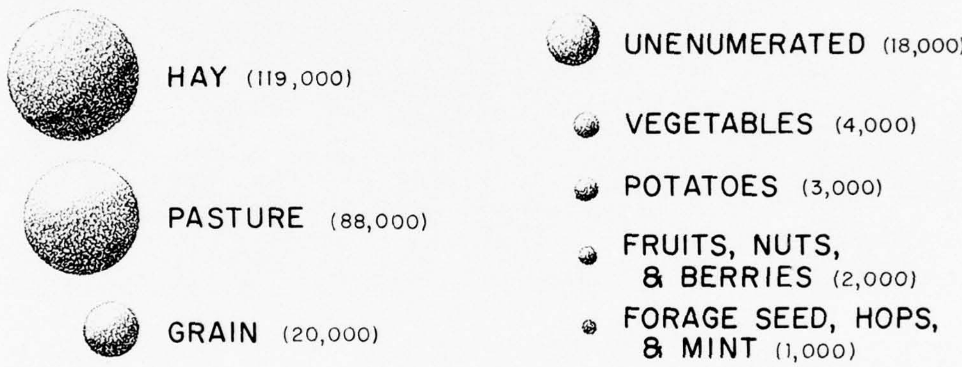



FIGURE 33. Acreage of Irrigated Cropland Harvested and Pasture. 1964, Subregion 6

## Production of Irrigated Crops

Total crop production and production from irrigated land are summarized in table 89. Yields of selected irrigated crops follow in table 90.

Irrigation is not the dominant factor in this subregion that it is in some others. All of the sugar beets and potatoes and all fruits are grown under irrigation; however, these are not major crops. Hay is the principal irrigated crop category with nearly 44 percent of production coming from irrigated land.

Table 89 - Summary of Crop Production, 1964, Subregion 6

| Crop Category | Units | Production Total | Production Irrigated | Percent Irrigated |
|---|---|---|---|---|
| | | (1,000's) | | |
| Small grains | tons | 1,524 | 25 | 1.6 |
| All hay | tons | 537 | 236 | 43.9 |
| Dry beans and peas | cwt. | 3,099 | 3 | 0.1 |
| Sugar beets | tons | 1 | 1 | 100.0 |
| Potatoes | cwt. | 384 | 384 | 100.0 |
| Vegetables | cwt. | 389 | 90 | 23.1 |
| Fruits, nuts, and berries | tons | 5 | 5 1/ | 100.0 |
| Forage seed, hops, and mint | lbs. | 72,280 | 650 | 0.9 |

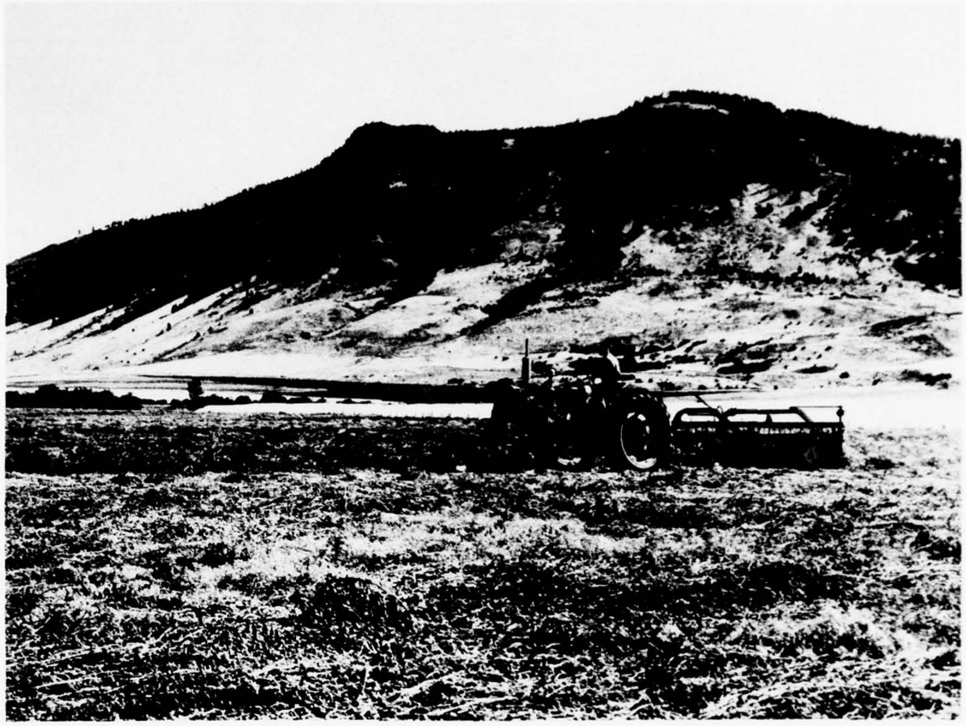
1/ Estimated.
Source: Derived from Census of Agriculture and Agricultural Statistics.

Table 90 - Yields for Selected Major Irrigated Crops, 1964, Subregion 6

| Crop | Units | Yield per Irrigated Acre |
|---|---|---|
| Grain | | |
| Wheat, winter | tons | 1.62 |
| spring | tons | 1.14 |
| Barley | tons | 1.18 |
| Oats | tons | 1.56 |
| Hay | | |
| Alfalfa | tons | 2.3 |
| Other | tons | 1.6 |
| Potatoes | cwt. | 132 |

## Value of Production

The value of crops, livestock, and livestock products associated with irrigation was estimated at nearly $11 million in 1964. Field crops, vegetables, and fruits accounted for less than $3 million of the total while livestock and livestock products made up the remaining value. These figures compare to total agricultural values of $119 million for crops and $32 million for livestock and livestock products.



*An excellent crop of irrigated alfalfa is being harvested in the Grande Ronde Valley; irrigated lands produce over a fifth of the subregion's livestock feed. (Bureau of Reclamation)*

## Economic and Social Impacts

Irrigated agriculture has not brought about impacts on the subregion's economy that have been experienced in other subregions because it has not been as extensively adopted. Over a large part of the subregion climatic conditions are such that a very healthy agriculture can exist without irrigation. However, in those areas where irrigation has proven to be beneficial, impacts have been significant.

The total value of agricultural output associated with irrigated land was estimated at $11 million. Applying the same multiplier developed from the Columbia Basin Study results in a gross impact of nearly $39 million. This is presented in table 91. However, this estimate should be used with some caution. The major crops grown in this subregion do not require the degree of local processing that is experienced in the Columbia Basin and in Subregions 4 and 5. Therefore, the multiplier for estimating local area impacts is probably not as large for this subregion.

Table 91 - Gross Value of Agricultural Products and Services Associated With Irrigation Use, 1964, Subregion 6

| Industry | Gross Value (millions) |
|---|---|
| Irrigated agriculture | $11 |
| Processing | 9 |
| Trades and services | 19 |
| Total | $39 |

## Use of Water

Of the 276,000 acres irrigated, 262,000 acres obtain their water supplies from surface flows of the subregion, 11,000 acres are irrigated from ground water and 3,000 acres are served with surface water from the Columbia Basin Project in Subregion 2. Irrigation diversions for the 1966 level of development average about 1.1 million acre-feet annually of which 35,000 acre-feet come from ground water and 10,000 acre-feet come from Subregion 2. Average water use is summarized by subarea in table 92.

Table 92 - Use of Water for Irrigation, 1966 level, Subregion 6

| | Irrigated Lands | | | | |
|---|---|---|---|---|---|
| Subarea | Adequate Supply (acres) | Inadequate Supply (acres) | Annual Diversions (ac-ft) | Return Flow (ac-ft) | Depletion (ac-ft) |
| Imnaha and Grande Ronde Rivers | 47,100 | 54,500 | 255,000 | 91,000 | 164,000 |
| Palouse and Lower Snake Rivers | 21,200 1/ | 10,500 | 124,000 | 63,000 | 61,000 |
| Salmon and Clearwater Rivers | 80,700 | 62,000 | 706,000 | 398,000 | 308,000 |
| Total | 149,000 2/ | 127,000 | 1,085,000 | 552,000 | 533,000 |

1/ About 3,000 acres of these lands receive 10,000 acre-feet of diversion from Subregion 2.

2/ Includes 11,000 acres served from ground water; all other lands served from surface water.

Return flows are estimated to total 552,000 acre-feet annually, including some 6,000 acre-feet from the 3,000 acres of Columbia Basin Project lands. Since most of the irrigation diversions occur in the upper reaches of the Salmon and Grande Ronde River valleys, the return flows are available for reuse in the lower parts of the subregion.

The total annual depletion due to irrigation diversions is estimated at 533,000 acre-feet. Over half of this depletion occurs in the upper Salmon River drainage and over one-fourth occurs in the Grande Ronde River valley. The remainder is scattered throughout the rest of the subregion.

## Adequacy of Supply

An estimated 127,000 acres irrigated from streamflows have water shortages averaging about 130,000 acre-feet. Almost all of the lands with water shortages are located in the upper reaches of the Salmon and Grande Ronde River drainages where streams have extremely low flows in the later months of the growing season. The remaining 149,000 irrigated acres in the subregion, including all lands supplied by ground water, are believed to have adequate water supplies. The 3,000 acres of Columbia Basin Project lands are among those with adequate supplies.

## Application of Water

Irrigation by gravity systems is the method of water application presently used on about 70 percent of the lands, particularly the Idaho lands at the higher elevations. However, because of more efficient water management, sprinkler irrigation is gaining in importance. Many of the irrigated lands in Oregon and Washington are sprinkler irrigated. In Oregon's Grande Ronde valley, for example, some irrigators using surface water are converting from gravity to sprinkler systems, and most of the irrigators using ground water also use sprinkler systems. Most of the irrigated lands in Washington are sprinkler irrigated.

Because most of the potentially irrigable lands in Subregion 6 have topographic features which make them unsuitable for irrigation by gravity methods, new development is expected to make sprinkler application increasingly important.

## Quality of Water

The quality of water for irrigation is good; there seems to be no deterrent to new irrigation development from a water

quality standpoint. The tributary streams in the subregion in general have a considerable diluting effect on the Snake River. As the river enters the subregion, its dissolved solids content exceeds 300 parts per million; as it leaves the subregion, it has only 150 parts per million. Ground water is generally excellent for irrigation.

The impact of irrigation on water quality appears to be minimal since only 5 percent of the surface runoff is diverted for irrigation. Irrigation in the Grande Ronde River drainage has caused some increase in mineral content downstream, but the content is still lower than that of the Snake River at its confluence with the Grande Ronde.

## FUTURE NEEDS

Irrigation in the eastern portion of the subregion has been limited to the production of pasture and a few short-season crops. The Palouse area is extensively dryfarmed since rainfall is adequate for grain production; in fact, only 1 percent of the wheat and 3 percent of the barley are produced on irrigated land. Irrigation is important, however, in the subregion's forage, fruit, and vegetable production.

Irrigation development has been slow in Subregion 6, due largely to the rugged terrain of much of the subregion. In addition, dryland crop production is very successful on many of the subregion's best lands, particularly those in the Palouse area. Subregion 6 contains about 3.3 million acres of dry land physically suited for irrigation and 127,000 acres of irrigated land needing supplemental water supplies.

According to projections, 494,000 acres of new irrigation development will be needed in Subregion 6 by 2020 to meet food and fiber requirements. To supply the needed supplemental water and the water needed for the new lands would require an additional farm delivery of about 1.5 million acre-feet.

### Lands

Increased production requirements will place greater importance on development of irrigated land. A summary of irrigated area needs is presented in table 93. The acreages of total irrigated area are inclusive of all land classed as irrigated whether productive or nonproductive.

Table 93 - Irrigated Area Needs by 1980, 2000, and 2020, Subregion 6

| Item | Irrigated Acreage 1980 | 2000 (1,000's) | 2020 |
|---|---|---|---|
| Harvested cropland and pasture 1/ | 374 | 468 | 654 |
| Other 2/ | 66 | 82 | 116 |
| Total irrigated area | 440 | 550 | 770 |

1/ From table 94.
2/ Includes irrigated forest, range, rights-of-way, ditches, roadways, farmsteads, urban, and idle irrigated lands not used in the production of projected crop requirements.

Productive irrigated land used to produce crops and livestock is summarized by crop category in table 94. Irrigated small grain acreage need is projected to remain fairly stable from 1980 to 2020. This is due to the high projected yields. Relatively large increases in acreage are projected for forage crops.

Table 94 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020, Subregion 6

| Crop Category | Acreage Needs 1980 | 2000 (1,000's) | 2020 |
|---|---|---|---|
| Small grains | 108 | 95 | 106 |
| All hay | 117 | 164 | 234 |
| Dry beans and peas | 16 | 31 | 56 |
| Sugar beets | - | - | - |
| Potatoes | 4 | 6 | 7 |
| Vegetables | 6 | 6 | 8 |
| Fruits, nuts, and berries | 1 | 1 | 1 |
| Forage seed, hops, and mint | 10 | 14 | 21 |
| Pasture | 87 | 119 | 177 |
| Unenumerated | 25 | 32 | 44 |
| Total | 374 | 468 | 654 |

## Production and Yield

Crop production from projected irrigated acreage needs is summarized in table 95. Crop yields are illustrated in figure 34 in index form to show percentage increases projected with 1964 yields as the projection base. For those crop categories containing more than one crop, the yield indexes are weighted averages.

Table 95 - Crop Production from Projected Irrigated Acreage for 1980, 2000, and 2020, Subregion 6

| Crop Category | Units | Production 1980 | 2000 (1,000's) | 2020 |
|---|---|---|---|---|
| Small grain | tons | 190 | 214 | 288 |
| Hay | tons | 305 | 508 | 878 |
| Dry beans and peas | cwt. | 295 | 707 | 1,525 |
| Potatoes | cwt. | 746 | 1,346 | 1,780 |
| Vegetables | cwt. | 193 | 237 | 406 |
| Fruits, nuts, and berries | tons | 2 | 4 | 5 |
| Forage seed, hops, and mint | lbs. | 13,693 | 24,109 | 46,490 |

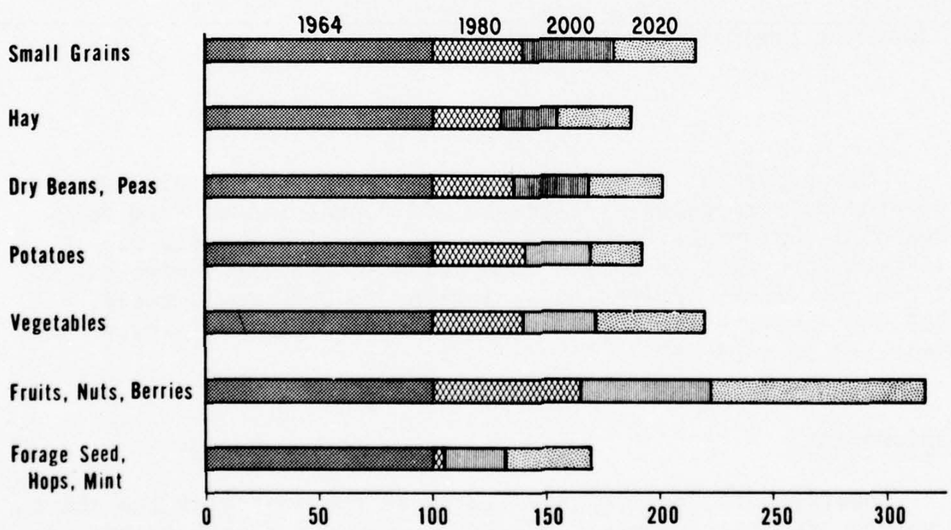



FIGURE 34. Projected Crop Yields in 1980, 2000, and 2020 for Selected Crops (1964 as Base Year Equals 100), Subregion 6.

## Value of Production

Values of irrigated crop production based on the same price structure used by the Office of Business Economics and the Economic Research Service (OBERS) in the regional projections are presented in table 96. These values include irrigated crops fed to livestock but do not include the value of the associated livestock and livestock products.

Table 96 - Value of Projected Irrigated Crop Production
Subregion 6

| Crop Category | Value of Production 1/ 1980 | 2000 ($1,000) | 2020 |
|---|---|---|---|
| Small grains | 10,000 | 11,300 | 15,200 |
| Hay | 6,600 | 10,900 | 18,900 |
| Dry beans and peas | 1,500 | 3,800 | 8,200 |
| Sugar beets | - | - | - |
| Potatoes | 1,000 | 1,800 | 2,400 |
| Vegetables | 600 | 700 | 1,200 |
| Fruits, nuts, and berries | 200 | 500 | 600 |
| Forage seed, hops, and mint | 2,800 | 5,000 | 9,700 |
| Total | 22,700 | 34,000 | 56,200 |

1/ Based on projected normalized prices.

## Water

Supplying the needed supplemental water and providing the projected full supplies will create additional annual farm deliveries of 1,550,000 acre-feet and an additional depletion of 1,167,000 acre-feet in 2020. When added to present depletions of 533,000 acre-feet, irrigation depletions in 2020 would total 1,700,000 acre-feet annually. Depletions and farm deliveries are summarized in table 97.

### Supplemental

Nearly half the irrigated lands in the subregion are short of water. To fully supply these inadequately irrigated lands, an additional annual supply of 130,000 acre-feet needs to be developed. This amount of diversion will produce increased farms deliveries of 80,000 acre-feet annually and depletions of 67,000 acre-feet annually. The annual supplemental need by subarea is shown in table 98.

Table 97 - Projected Farm Deliveries and Depletions, Subregion 6

| Year | Presently Irrigated Farm Delivery | Presently Irrigated Depletion | Future Irrigation Farm Delivery | Future Irrigation Depletion | Total Farm Delivery | Total Depletion |
|---|---|---|---|---|---|---|
| | | | (1,000 acre-feet) | | | |
| 1966 | 720 | 533 | -- | -- | 720 | 533 |
| 1980 | 800 | 600 | 500 | 370 | 1,300 | 970 |
| 2000 | 800 | 600 | 840 | 620 | 1,640 | 1,220 |
| 2020 | 800 | 600 | 1,470 | 1,100 | 2,270 | 1,700 |

Table 98 - Supplemental Irrigation Diversion Requirements, Subregion 6

| Subarea | Water-Short Lands (acres) | Supplemental Diversion Requirement (acre-feet) |
|---|---|---|
| Imnaha and Grande Ronde | 54,500 | 40,000 |
| Palouse and Lower Snake | 10,500 | 10,000 |
| Salmon and Clearwater | 62,000 | 80,000 |
| Total | 127,000 | 130,000 |

Full

The largest per acre irrigation deliveries are required for lands at the lower elevations near the mouth of the Snake River. The remaining areas, at higher elevations, require less water because of cooler temperatures and shorter growing seasons. Requirements in the remaining areas are somewhat less because of higher elevation. The highest irrigable lands are located in the Salmon River basin between several mountain ranges extending roughly north and south. These ranges cause a rain-shadow effect resulting in irrigation requirements comparable to lands several thousand feet lower in elevation. Estimated unit farm delivery requirements and depletions for new lands to be irrigated by 2020 are shown in table 99.

Table 99 - Irrigation Requirements and Use
Subregion 6

| Subarea | Present - 2000 Farm Delivery (AF/ac.) | Present - 2000 Depletion (AF/ac.) | 2000 - 2020 Farm Delivery (AF/ac.) | 2000 - 2020 Depletion (AF/ac.) |
|---|---|---|---|---|
| Imnaha and Grande Ronde River basins | 2.3 | 1.7 | 2.8 | 2.1 |
| Palouse | 2.9 | 2.1 | 2.9 | 2.2 |
| Lower Snake | 3.3 | 2.5 | 3.7 | 2.7 |
| Salmon River basin | 3.2 | 2.3 | 2.6 | 1.9 |
| Clearwater River basin | 2.8 | 2.0 | 2.5 | 1.8 |

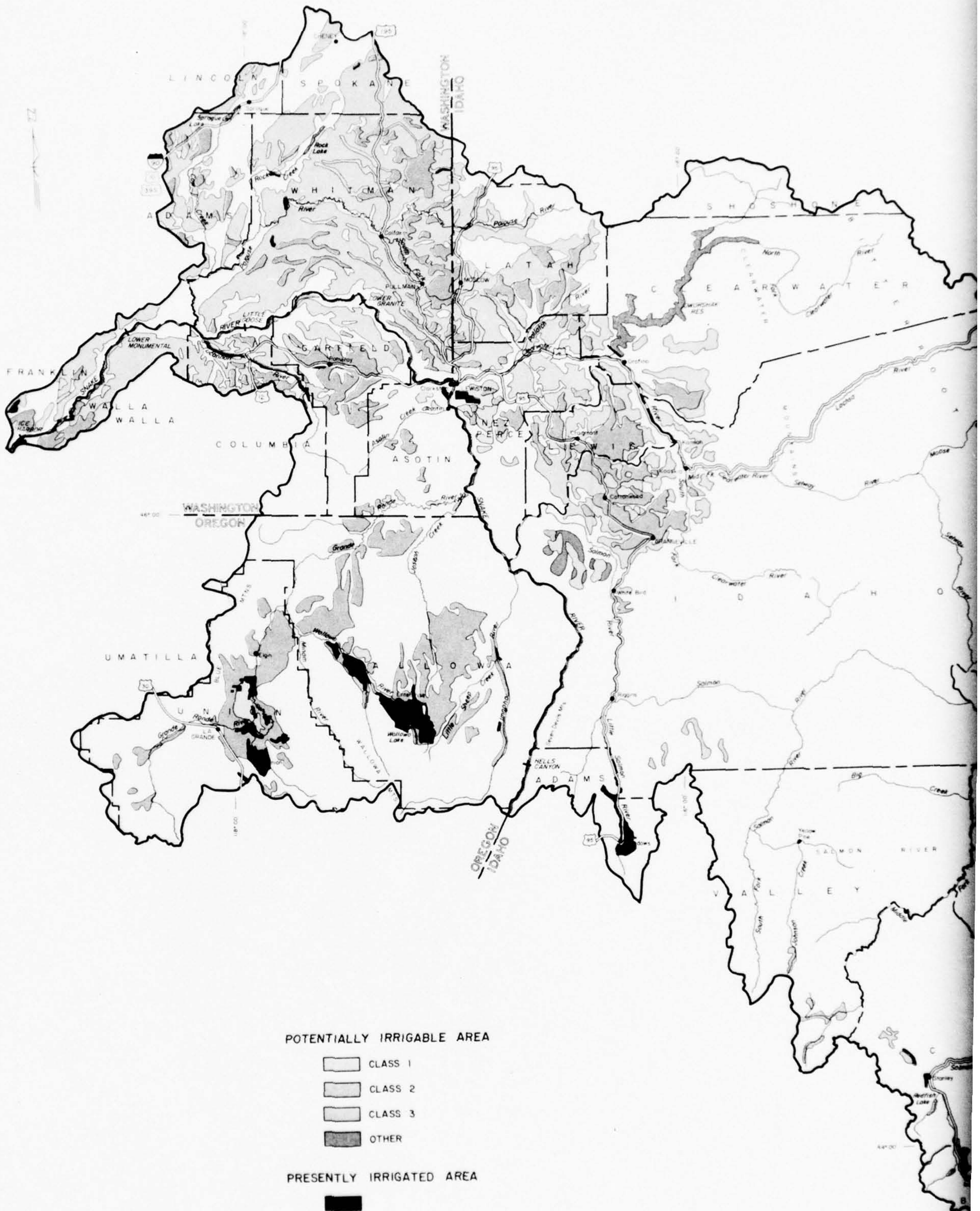
## THE POTENTIAL TO MEET THE NEEDS

More than 3.3 million acres of potentially irrigable lands have been identified in Subregion 6, 12 times the amount now irrigated. Subregion 6 contains 10 percent of the potentially irrigable lands in the Columbia-North Pacific Region. The location of these lands is shown on figure 35.

Subregion 6 is unique among areas of the Snake River basin in that it has more water originating within its boundaries than would be required to irrigate all its potentially irrigable lands. On an average annual basis, almost 21.5 million acre-feet of water originate in the subregion, as compared to the subregion's 3.3 million acres of potentially irrigable lands. However, many of these lands are located far from the available water supplies, and many are now effectively dryfarmed. To meet food and fiber needs of the region, a total of 494,000 acres needs to be developed for irrigation by 2020. Presently irrigated lands having water shortages will also need to be provided with a full supply.

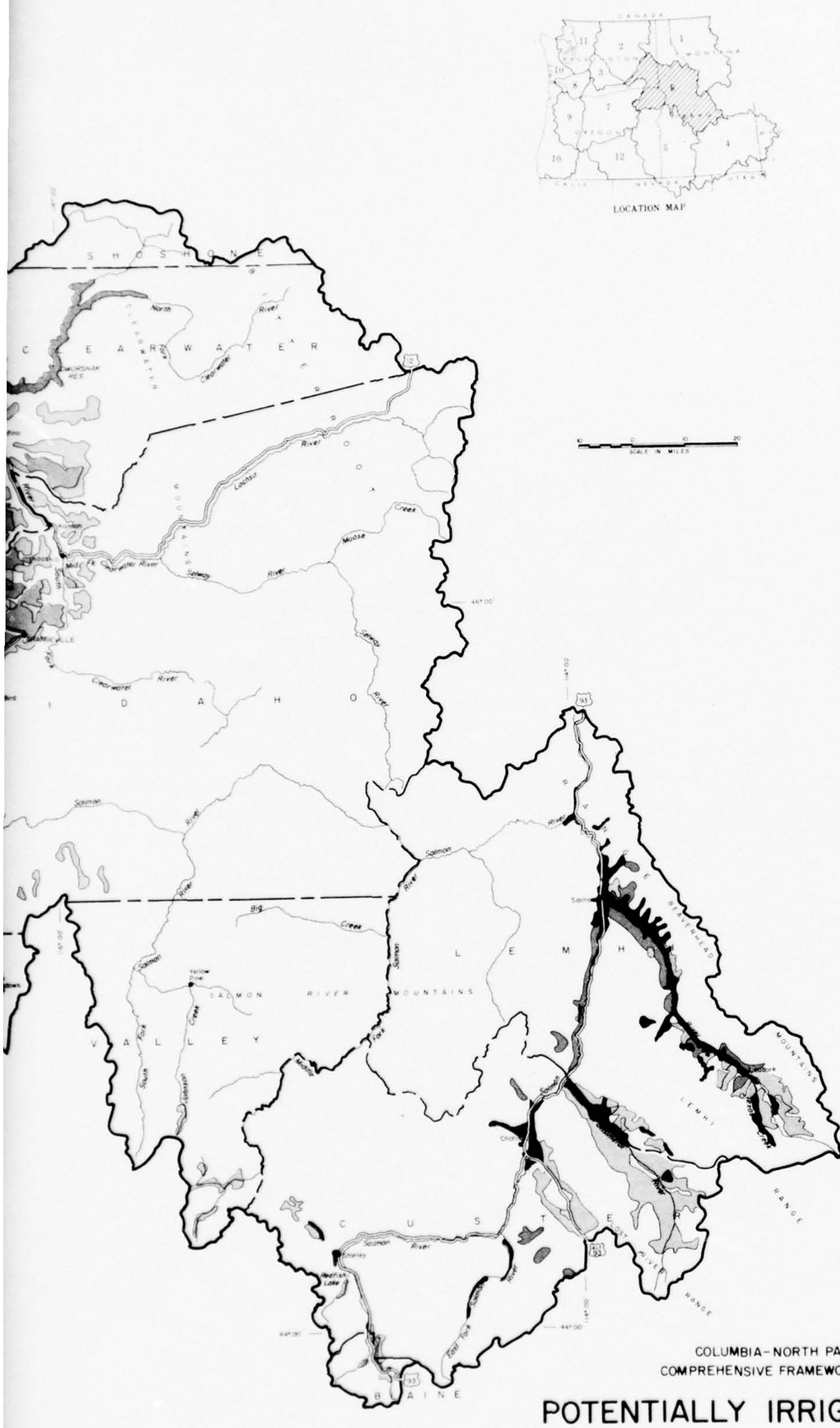
### Potentially Irrigable Lands

Based on specifications developed for the Columbia-North Pacific Study, 3,320,200 acres have been identified as potentially irrigable and placed in three irrigability classes. These lands are suited for agricultural uses although in some cases they may have greater potential for nonagricultural purposes. An additional 71,000 acres are in an "other" category. Under irrigation, they would be primarily suited to producing limited forage for wildlife and livestock grazing since they are not generally suitable for more intensive uses. The results of the land classification are shown in table 100.



LINCOLN
SPOKANE
WHITMAN
ADAMS
FRANKLIN
WALLA WALLA
COLUMBIA
GARFIELD
ASOTIN
LATAH
NEZ PERCE
LEWIS
CLEARWATER
SHOSHONE
IDAHO
UMATILLA
UNION
WALLOWA
ADAMS
VALLEY
WASHINGTON
IDAHO
WASHINGTON
OREGON
OREGON
IDAHO
LOWER MONUMENTAL
LOWER GRANITE
HELLS CANYON
Pullman
Colfax
Lewiston
Wallowa Lake
SALMON RIVER
POTENTIALLY IRRIGABLE AREA
CLASS 1
CLASS 2
CLASS 3
OTHER
PRESENTLY IRRIGATED AREA

2




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# POTENTIALLY IRRIGABLE AREA

LOWER SNAKE, SUBREGION 6

1968

FIGURE 35

Table 100 - Potentially Irrigable Lands
Subregion 6

| State | Class 1 | Class 2 | Class 3 | Subtotal | Other | Total |
|---|---|---|---|---|---|---|
| | | | (acres) | | | |
| Washington | 96,800 | 339,800 | 1,224,600 | 1,661,200 | - | 1,661,200 |
| Idaho | 55,000 | 341,300 | 840,900 | 1,237,200 | 70,900 | 1,308,100 |
| Oregon | 18,900 | 386,400 | 16,500 | 421,800 | - | 421,800 |
| Total | 170,700 | 1,067,500 | 2,082,000 | 3,320,200 | 70,900 | 3,391,100 |
| Percent | 5 | 32 | 61 | 98 | 2 | 100 |
| Subarea | | | | | | |
| Imnaha and Grande Ronde Rivers | 19,600 | 395,400 | 20,300 | 435,300 | - | 435,300 |
| Palouse and Lower Snake Rivers | 132,400 | 351,900 | 1,330,000 | 1,814,300 | 15,400 | 1,829,700 |
| Salmon and Clearwater Rivers | 18,700 | 320,200 | 731,700 | 1,070,600 | 55,500 | 1,126,100 |
| Total | 170,700 | 1,067,500 | 2,082,000 | 3,320,200 | 70,900 | 3,391,100 |

As shown on figure 35, about half the potentially irrigable lands are located in Washington, with three-fourths of the remainder in Idaho. Though few lands were placed in class 1, nearly a third were placed in class 2; these higher quality lands are almost evenly divided among the subregion's three states.

Some of the higher quality land is located near the presenly irrigated areas, and much of it is now dryfarmed. With irrigation development, cropping patterns would probably be similar to those on adjacent irrigated areas, and crop production should equal that of the irrigated lands of comparable quality.

However, most of the potentially irrigable lands are located far from available water supplies; in many areas irrigation development would be expensive, requiring complex distribution systems. Topographic deficiencies have relegated most of the lands of the subregion to the lowest irrigable class; the degree of slope found on many of these lands will restrict their use under irrigation to forage, pasture, and small grain crops. Sprinkler irrigation

*These potentially irrigable prairie lands around Cottonwood, Idaho, are now dryfarmed. Many of the subregion's potentially irrigable lands have rolling topography and are far from available water supplies. (Bureau of Reclamation)*

would increase the efficiency of water application and minimize erosion damage.

## Class 1

Making up only 5 percent of the potentially irrigable lands of Subregion 6, class 1 lands are generally scattered throughout the northwestern and central parts of the subregion. These lands are of the highest quality and are well suited for irrigation. With adequate water they will produce good yields of climatically adapted crops.

Class 1 soils are medium textured and well drained and have excellent water-holding capacities. Depth exceeds 40 inches to restricting layers or to sand, gravel, and cobble; there are at most only small quantities of surface rock. Concentrations of slick spots, when present, cover less than 10 percent of the area, and salt and alkali problems are negligible or easily corrected. These lands may have only minor topographic deficiencies, including slopes up to 5 percent.

## Class 2

Class 2 lands make up about a third of the potentially irrigable lands in Subregion 6. Most of these lands are found in the western and north-central parts of the subregion. About 92 percent of the potentially irrigable land in the Oregon portion of this subregion is class 2, and much of this land is near the presently irrigated areas.

Class 2 lands are moderately productive. Soil textures range from loamy sand through permeable clays, with 20 inches or more of soil over sand, gravel, cobble, or restricting layers such as hardpan or caliche. Water-holding capacities are good. Drainage is generally good, except in some small areas with heavy soil textures or in level areas such as the Grande Ronde Valley. A large acreage of class 2 land has interspersed slick spots. Many of the class 2 lands have slopes up to 12 percent and are therefore best suited to sprinkler irrigation.

## Class 3

Class 3 lands make up nearly two-thirds of the potentially irrigable acreage in the subregion. Totaling over 2 million acres, these lands are often found in large blocks, mainly in the northwestern part of the subregion.

Soil textures vary from loamy sands to clays. Depths of soil over sand, gravel, cobble, or restricting layers may be as little as 10 inches. Some class 3 lands have drainage problems, while others have limited water-holding capacities.

Many of the class 3 lands have steep slopes. Slopes of 15 to 20 percent are quite common, especially in the northwestern portion of the subregion.

## Other

In addition to the lands included in the above classification, 70,900 acres of lands have been identified as having a long-range potential for range forage production or wildlife habitat improvement under irrigation. Though these lands do not generally meet the minimum criteria for class 3 lands, they are included here in order to identify the ultimate potential in the subregion.

## Water Supply

About 12 million acre-feet of surface water enters the subregion and 34 million acre-feet leaves it. Therefore, net

discharge originating within the subregion amounts to some 22 million acre-feet annually.

Some 31 million acre-feet of ground water are stored at depths of 50 to 100 feet below the water table. Estimated annual natural recharge is 9 million acre-feet while the net annual recharge is about 8 million acre-feet.

## Potential Developments

Significant development potential exists in the three subareas.

Part of the subregion's irrigation requirement can be provided by large project-type development, but the majority must be provided by smaller project works or through corporate and individual effort.

According to projections, an average of 16,000 acres of new land must be irrigated each year to meet the projected need for an additional 164,000 acres by 1980. Over the succeeding 20 years the desired rate of development would drop to only 5,500 acres annually; and from 2000 to 2020, the rate of new irrigation needed would increase to 11,000 acres annually. The average required rate of increase through 2020 is approximately 10,000 acres annually.

Surface flows in tributary streams, particularly the upper Grande Ronde River and upper tributary streams of the Salmon River, have been appropriated to the extent that a dependable supply for new irrigation cannot be obtained without new storage. Large-scale development from ground water does not appear likely, except in the Grande Ronde valley. Small acreages will continue to be privately developed from ground water in many portions of the subregion, however.

### Development by Subarea

Grande Ronde and Imnaha Rivers The Grande Ronde and Imnaha River basins, located in the northeast corner of Oregon and in a small portion of the southeast corner of Washington, contain less than a half million acres of potentially irrigable land. Though water is available in the Imnaha River, this drainage contains few potentially irrigable lands. The Grande Ronde River discharges an average of less than 1.5 million acre-feet annually and appears inadequate to irrigate all the potentially irrigable lands in the drainage. Though these potentially irrigable lands are generally of class 2 quality, many are located

far from available water supplies. An exception is those lands located in the upper Grande Ronde valley near LaGrande. Parts of the Grande Ronde valley also have significant ground water supplies that could be developed concurrently with new surface water development.

Palouse and Lower Snake Rivers This subarea contains over 1.8 million potentially irrigable acres--more than half the subregion's potentially irrigable land.

Conditions are most favorable for future irrigation development in the lower portion of this subarea, generally downstream from the mouth of the Palouse River. This so-called "Lower Snake" portion contains a total of some 200,000 potentially irrigable acres, with over half of this acreage lying south of the Snake River. Most of the lands lie at elevations of from 100 to 1000 feet above the Snake River; the better quality lands are found near its mouth.

Most of the potentially irrigable lands in the subarea are located in the Palouse River drainage north of the Snake River. This drainage contains 1.3 million acres of potentially irrigable land, 160,000 acres of which are in Idaho. These lands, commonly called the Palouse Hills, are rolling and loess-covered; most are class 3 because of topography. Much of the subarea is now successfully dryfarmed, with wheat the principal crop. According to available data, ground water cannot be relied upon as a primary source of supply for new irrigation. However, portions of the Palouse River drainage could be irrigated from one of several surface sources:

1. Pumping from the Snake River. However, most of the irrigable lands are located at considerable distance from the river and much of the lands are at elevations of from 1000 to over 2000 feet above the Snake.

2. Storage on the Palouse River or its tributaries. The Palouse River discharges an average of nearly 400,000 acre-feet annually, but storage would be needed to make the flows usable for irrigation.

3. Diversions into Subregion 6 from the Spokane or Columbia Rivers.

The remaining 300,000 acres are located south of the Snake River around the town of Pomeroy and along the Tucannon River and its tributaries. These lands are quite similar to those of the Palouse River drainage, and their irrigation development would involve many of the same difficulties. The most likely sources of water for new irrigation are:

1. Pumping from the Snake River. The distances and elevations from the Snake River for most of these lands are similar to those of the Palouse basin lands. However, lands along the lower Tucannon River would not require as high a pump lift.

2. Storage on the Tucannon River or other streams. Some lands might be irrigated from storage on the Tucannon River or its principal tributary, Pataha Creek. Storage on Asotin, Deadman, and Alpowa Creeks, all Snake River tributaries, is also being considered.

Clearwater and Salmon Rivers The Salmon and Clearwater drainages contain over 1 million acres of potentially irrigable land. Just over 250,000 acres of this land are located in the upper reaches of the Salmon River and its tributaries. The remaining lands are in the lower reaches of the Salmon and Clearwater basins. The vast and rugged area between the upper drainages and the lower reaches of the Salmon River has virtually no potentially irrigable land. Likewise, none of the upper Clearwater River or its tributary basins contain potentially irrigable land. Parts of these upper drainages are included in primitive areas and reaches of several streams have been designated as wild rivers or potential wild rivers.

Irrigation season flows of the upper Salmon River tributaries are already heavily used, and many irrigated lands experience water shortages. New development would require storage facilities on the smaller tributaries where the potentially irrigable lands are located.

Difficulties in obtaining a water supply and the success of the existing dryfarm operations will also restrict new irrigation development in the lower Salmon and Clearwater River drainages. The best land potential is probably the Palouse-like Camas Prairie area around the towns of Grangeville and Cottonwood, much of which has class 1 or 2 lands. However, developing a water supply for this area from either the Clearwater or the Salmon River would require pump lifts of approximately 2,000 feet.

## Private Development

The majority of the subregion's irrigation potential will most likely be provided through private and individual effort. Private irrigators have recently been developing portions of this area by pumping from Lake Sacajawea, the reservoir formed by Ice Harbor Dam. It appears likely that this type of private development will continue.

## Federal Developments

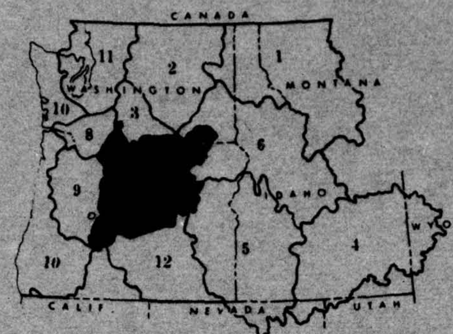
The Grande Ronde River basin has the immediate potential for a large Federally-financed project in the vicinity of LaGrande. The proposed project could irrigate well over 60,000 acres of dry land and relieve existing water shortages on over 20,000 acres of irrigated land. The water supply for this potential project is based on two authorized storage reservoirs in the upper reaches of the Grande Ronde River drainage and on extensive ground water pumping in the Grande Ronde valley.

The Palouse and Tucannon River drainages have large potentially irrigable acreages, but much of the land is now successfully dryfarmed. Many of these lands, though highly productive when dryfarmed, were placed in the lowest potentially irrigable category because of their complex, rolling topography. Because of their distance from potential water supplies, conveying water to the lands would be costly. In addition, either new tributary storage or 1,000- to 2,000-foot pump lifts from the Snake River would be required.

The lower Snake River portion is another likely area for development of large blocks of land. The Snake River appears to be the most desirable water source as substantial areas can be served by moderate pump lifts, particularly south of the river in the Eureka Flat area near the lower end of the subregion.

There are plans at the Federal level to provide storage to relieve water shortages on some 2,600 acres near Challis, Idaho.

Many of the potentially irrigable lands in the lower basins are also of the lowest irrigable class, and a significant portion of the lands north of the Clearwater River are forested. Many of these lower basin lands are also located at elevations far above available water supplies. If irrigated, these lands would probably receive their water supply by pumping from the lower Clearwater or Salmon Rivers. Small acreages could be served by storage on and diversions from Ciearwater River tributaries.



LOCATION MAP

SUBREGION 7

# SUBREGION 7

# MID COLUMBIA

## THE SETTING

Subregion 7 includes those lands in Oregon and Washington between the Cascade Range and the Blue Mountains drained by tributaries of the Columbia River. The subregion, having an area of approximately 29,600 square miles, represents 11 percent of the regional area. Approximately 82 percent of the area is in Oregon and 18 percent in Washington.

Mountain ranges and uplands surround an extensive plateau incised by several rivers. The Cascade Range on the west, Horse Heaven Hills on the north, Blue Mountains on the east, and extensive uplands on the south are the prominent landforms. The major streams from the east and south are the Walla Walla, Umatilla, John Day, Deschutes, and Hood Rivers; from the north are the White Salmon and Klickitat Rivers.

Climate is characterized by cool to cold winters and hot, dry summers. The Cascade Range influences the climate by lessening the effect of the moist and temperate maritime air masses as they move from west to east. Temperatures normally range from -30° F. in winter to 100° F. in summer. Annual precipitation, most of which falls in the November to April period, varies from 7 inches in the lower plateau and foothill areas to 40 inches in the Blue Mountains to more than 130 inches near the crest of the Cascades.

Natural vegetation reflects the precipitation pattern. In the lower areas sagebrush and grass predominate. These areas occupy more than 34 percent of the subregion. Many of the mountain slopes are forested; ponderosa pine is the principal commercial species. Forest lands cover about 44 percent of the subregion and are used for both timber production and grazing. Most of the remaining area is classed as cropland. Agricultural areas generally range from 500 to 4000 feet elevation.

In 1965 the population of the subregion was 210,000, or a density of seven people per square mile. The total population, which represents 3-1/2 percent of the region's population, is predominantly rural; only The Dalles, Pendleton, and Bend in Oregon and Walla Walla and Kennewick in Washington have populations over 10,000.

A network of Federal, state, and county roads crosses the subregion. Railroads traverse both shores of the Columbia River and serve all but the southeastern portion of the subregion with main line or branch line service. The largest communities have commercial airline service. The Columbia River is a heavily used navigable stream; barge tows connect the subregion to market and service centers both upstream and downstream.

Forestry, agriculture, and food processing are the primary economic activities of the subregion. Forest and forestry products industries are located throughout the subregion, especially near the forested portions of the mountain ranges and in the upper reaches of the larger tributary streams. A large ponderosa pine timber operation is located in the upper John Day River basin.

A wide variety of agricultural activity is found in the subregion. The counties bordering the Columbia River are noted for the production of dryland grain, primarily wheat, and grazing of livestock. Fruit production dominates the areas near Hood River, The Dalles, and Milton-Freewater, Oregon, and White Salmon, Washington. Production of livestock is the major agricultural activity in the more mountainous southeastern portion of the subregion. In the western portion, a more diversified agriculture exists, based on production of potatoes, specialty crops, and livestock.

A canning and frozen food industry, important to the overall economy, has developed in those areas where fruits, vegetables, and specialty crops are grown.

To facilitate handling and presenting data, the subregion has been divided into seven subareas based on hydrologic boundaries. They are the Walla Walla, Umatilla, Columbia River, John Day, Deschutes, Hood, and White Salmon-Klickitat. Figure 36 shows their location.

An economic subregion composed of Crook, Deschutes, Gilliam, Grant, Hood River, Jefferson, Morrow, Sherman, Umatilla, Wasco, and Wheeler Counties in Oregon and Columbia, Klickitat, and Walla Walla Counties in Washington is used for the economic studies and the projections.

Irrigation began in this subregion in the last third of the nineteenth century. It was apparent in many parts of the subregion that in order to get adequate yields and greater diversification in cropping a water supply was needed in addition to natural rainfall. Initial efforts were of a simple nature, usually direct diversions from smaller streams by an individual or a small group. One of the earliest irrigation endeavors in the Washington portion was the efforts by Marcus Whitman around 1845 in the Walla Walla subarea;

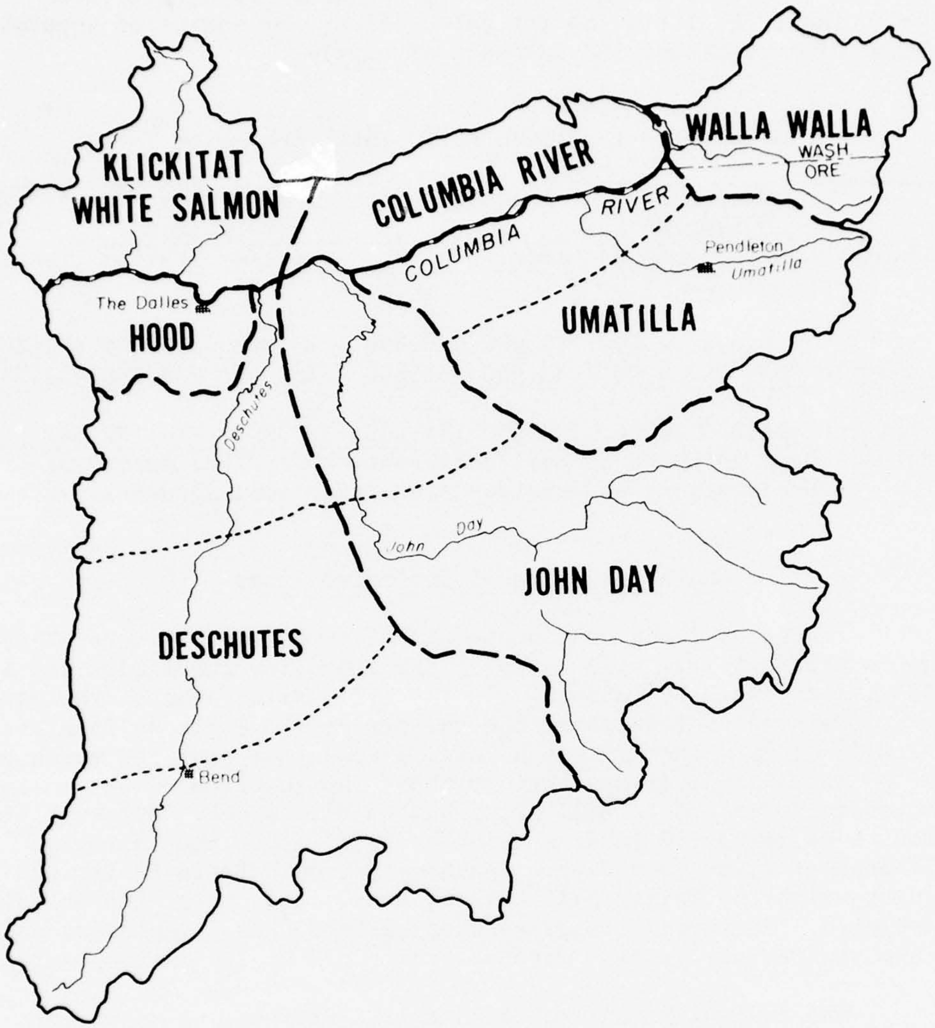



FIGURE 36. Subareas in Subregion 7, Mid Columbia.

in Oregon an early effort occurred on Squaw Creek in 1871 near the small community of Sisters in the Deschutes subarea. The irrigated acreage has increased gradually since these initial efforts. Sizable concentrations of irrigated land in various portions of the subregion have occurred through project-type development.

## PRESENT STATUS

About 542,000 acres were irrigated in 1966 in Subregion 7. Included are some irrigated lands in urban use, forest nurseries

and seed orchards, recreation sites, and other nonagricultural uses. Table 101 lists the irrigated acreage by source of supply, method of irrigation, and adequacy of supply.

Table 101 - Irrigated Area, 1966, Subregion 7

| State | Source of Supply | | Adequacy of Supply | | Method of Irrigation | | Total |
|---|---|---|---|---|---|---|---|
| | Surface | Ground | Adeq. | Inadeq. | Sprinkler | Gravity | |
| | (acres) | | | | | | |
| Oregon | 426,600 | 32,800 | 242,900 | 216,600 | 83,900 | 375,600 | 459,500 |
| Washington | 69,400 | 13,200 | 47,900 | 34,600 | 44,000 | 38,500 | 82,500 |
| Total | 496,000 | 46,000 | 290,800 | 251,200 | 127,900 | 414,100 | 542,000 |

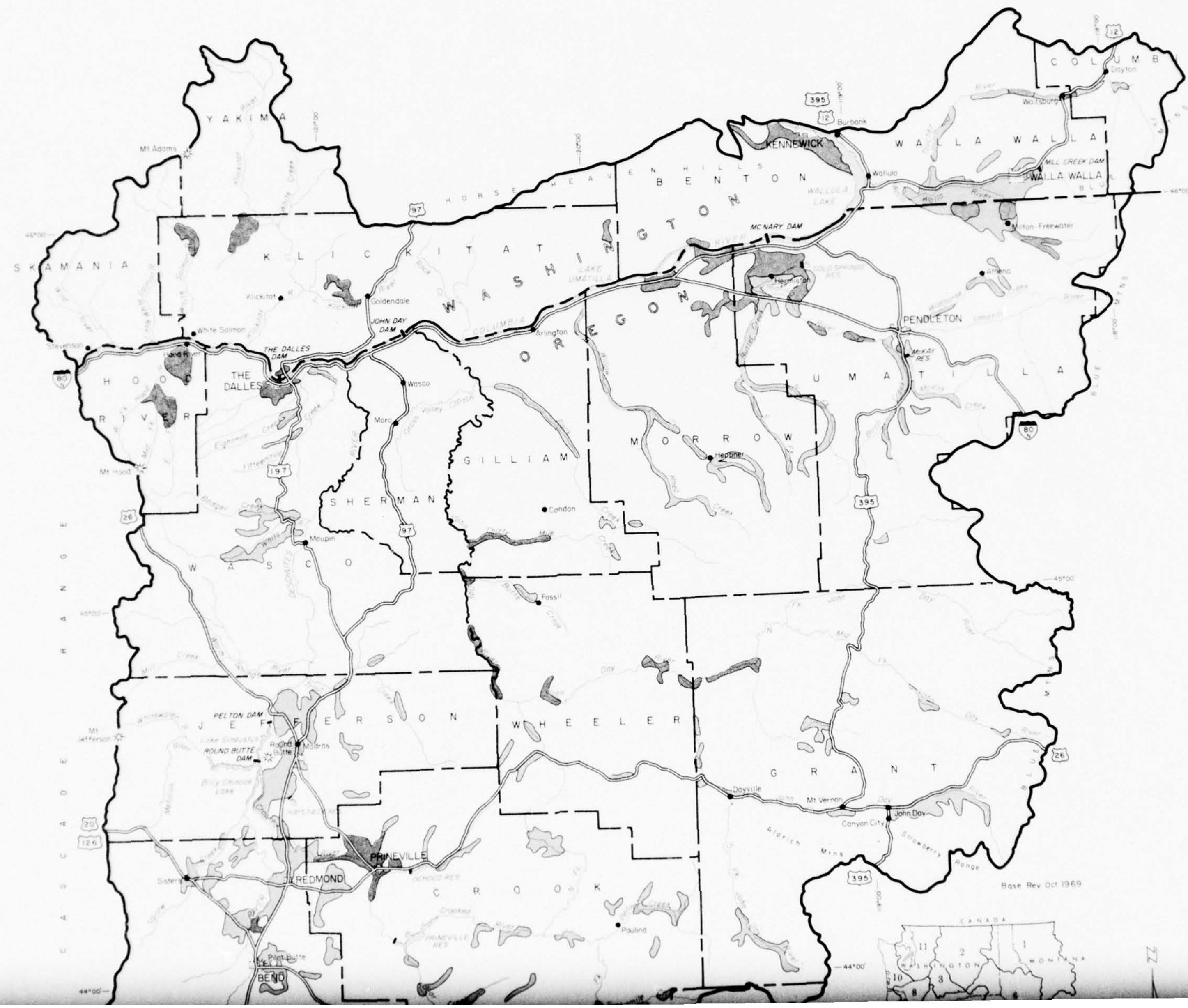
Source: Data gathered by Soil Conservation Service, Bureau of Reclamation, and various state and local agencies.

## Characteristics of Irrigated Areas

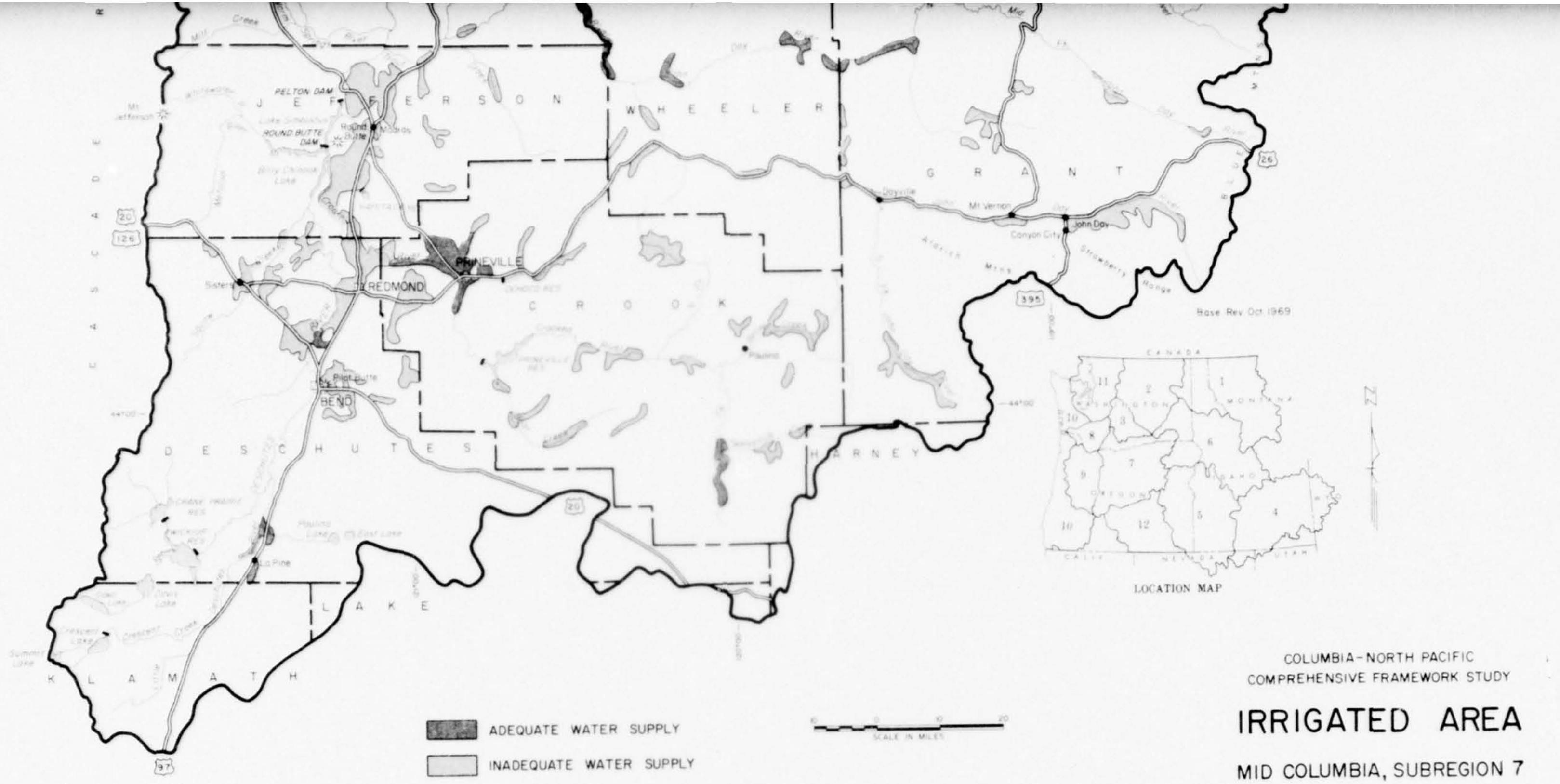
Irrigated lands are located in all subareas. Figure 37 shows the location of irrigated lands in the subregion and tables 104 and 105 give acreages by subarea. In the Walla Walla subarea the major irrigated area is located in the valleys of the Walla Walla River and Mill Creek. The irrigated lands extend from near the mouth of the Walla Walla River upstream to above the junction of its north and south forks and to Mill Creek Dam on Mill Creek. Substantial amounts of irrigated land can also be found along the valley of the Touchet River from Dayton, Washington, downstream to its confluence with the Walla Walla River. These lands have been privately developed. Principal irrigated crops include peas, asparagus and other vegetables, apples, melons, grain, pasture, and forage crops.

The Federally constructed Umatilla Project, which serves some 31,000 acres near Hermiston, Oregon, is in the Umatilla subarea. Emphasis is on forage crops, with grain, hops, sugar beets, vegetables, peppermint, melons, and tree fruits also being produced. Irrigators are sprinkler-irrigating crops similar to those produced on the Umatilla Project on lands along the Columbia River, especially in the Boardman to Arlington area. In the upper portions of this subarea irrigated farms lying along the streams produce forage in support of the livestock industry.

Approximately 20,000 acres near Kennewick, Washington, in the Columbia River subarea are irrigated to produce forage crops, row crops, and specialty crops including mint and asparagus. Most of the water for these lands is diverted from Subregion 3 (Yakima River) drainage. Other irrigated lands in this subarea are producing



WASHINGTON
OREGON
COLUMBIA
WALLA WALLA
BENTON
KLICKITAT
YAKIMA
SKAMANIA
HOOD RIVER
UMATILLA
MORROW
GILLIAM
SHERMAN
WASCO
WHEELER
GRANT
JEFFERSON
CROOK
KENNEWICK
WALLA WALLA
PENDLETON
THE DALLES
PRINEVILLE
REDMOND
BEND
MC NARY DAM
JOHN DAY DAM
THE DALLES DAM
MILL CREEK DAM
PELTON DAM
ROUND BUTTE DAM
HORSE HEAVEN HILLS
CASCADE RANGE
Base Rev Oct 1969




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# IRRIGATED AREA

MID COLUMBIA, SUBREGION 7

1968

2

FIGURE 37

such crops as grains, potatoes, and alfalfa; these lands receive water lifted several hundred feet from the Columbia River.

Irrigated agriculture in the John Day subarea is generally restricted to the stream valleys, with the major concentrations along the upper John Day River in the vicinity of John Day and along Rock and Thirty Mile Creeks. Throughout the subarea, essentially all irrigation is from private facilities. Nearly all the irrigated lands are used to produce forage for livestock.

Most of the irrigated agriculture in the Deschutes subarea is concentrated in large blocks irrigated from the Deschutes and Crooked Rivers. Potatoes, mint, beets, vegetables, grass seed, forage, and grain are irrigated. Federally constructed and rehabilitated projects now irrigate about half of the 165,000-acre total irrigated in the Bend-Prineville-Madras area. Irrigated lands scattered throughout the White River drainage in the northern part of this subarea produce forage crops and grain.

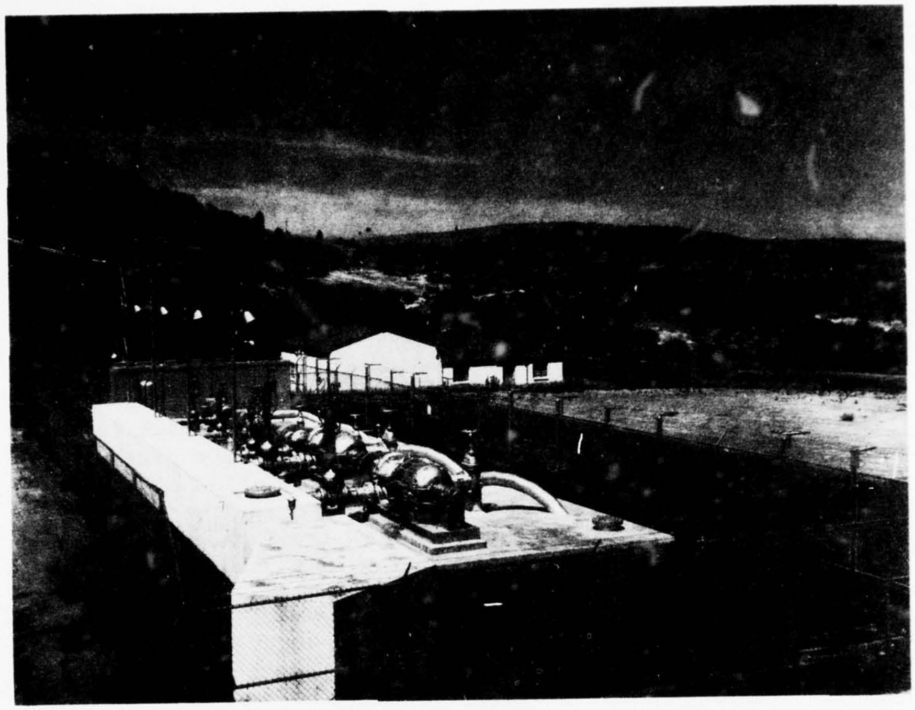
One of the Nation's best irrigated fruit producing areas is located in the Hood subarea. Irrigation is concentrated in the beautiful Hood River Valley and near The Dalles. Apple and pear orchards occupy most of the orchard land around Hood River. Ninety percent is irrigated--usually by sprinkler application of water from farmer-owned irrigation canals. Orchards near The Dalles produce cherries along with some apricots and peaches; the Federally constructed The Dalles project pumps to lands as high as 1200 feet above the Columbia River.

Three blocks of irrigated land are located along the Little Klickitat, White Salmon, and Outlet Creek drainages in the White Salmon-Klickitat subarea. Fruits, vegetables, and forage are the principal crops.

Total farmland in the subregion is divided into nearly 7,300 farm units having an average size of over 1,500 acres. About 4,700 of these farms irrigate to some extent. Farms having irrigated land average 1,360 acres in size but actually irrigate an average of only 86 acres each.

Of the 400,000 acres of harvested cropland and pasture irrigated in 1964 (according to the 1964 Census of Agriculture), 384,000 acres have been specifically identified with particular crops. Hay and pasture were grown on nearly 68 percent of the irrigated land identified; small grains on about 9 percent; and other field crops, fruits, vegetables, and unenumerated crops on the remaining 23 percent.

A summary of irrigated cropland harvested and pasture by crop category is presented in figure 38.



*One of the series of pumping plants that lift water 1,200 feet to sprinkler irrigate fruit orchards around The Dalles, Oregon. (Bureau of Reclamation)*

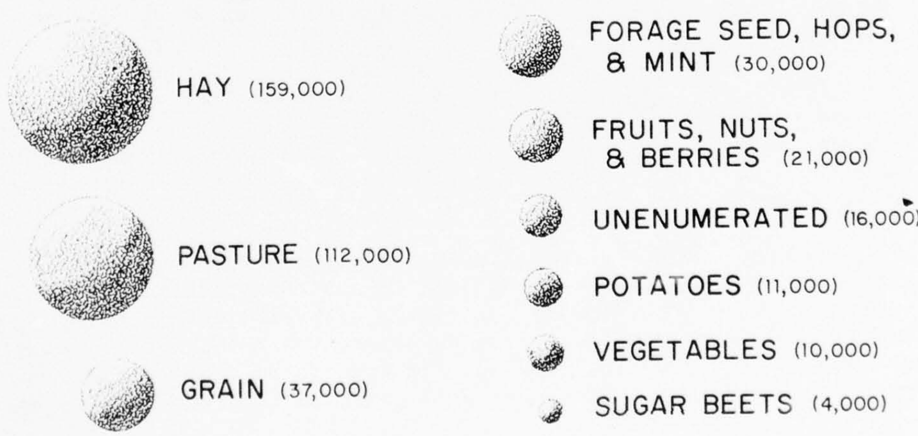



FIGURE 38. Acreage of Irrigated Cropland Harvested and Pasture, 1964, Subregion 7.

## Production of Irrigated Crops

Production of irrigated crops is compared with total production by crop category in table 102. The comparisons show that high percentages of such crops as sugar beets, potatoes, forage seeds, mint, fruit, and hay are irrigated in the subregion. Yields of selected major irrigated crops are shown in table 103.

Table 102 - Summary of Crop Production, 1964, Subregion 7

| Crop Category | Units | Production Total (thousands) | Production Irrigated (thousands) | Percent Irrigated |
|---|---|---|---|---|
| Small grains | tons | 1,175 | 62 | 5.3 |
| All hay | tons | 564 | 400 | 70.9 |
| Dry beans and peas | cwt. | 193 | -- | -- |
| Sugar beets | tons | 67 | 67 | 100.0 |
| Potatoes | cwt. | 2,777 | 2,777 | 100.0 |
| Vegetables | cwt. | 2,736 | 694 | 25.4 |
| Fruits, nuts, and berries | tons | 101 | 79 | 78.2 |
| Forage seed, hops, and mint | lbs. | 15,953 | 15,265 | 95.7 |

Source: 1964 Census of Agriculture and Agricultural Statistics.

Table 103 - Yields of Selected Major Irrigated Crops, 1964, Subregion 7

| Crop | Units | Yield per Irrigated Acre |
|---|---|---|
| Small grains | | |
| Wheat | tons | 1.82 |
| Barley | tons | 1.43 |
| Oats | tons | .96 |
| Corn | tons | 2.18 |
| Hay | | |
| Alfalfa | tons | 3.0 |
| Clover | tons | 1.7 |
| Wild hay | tons | 1.1 |
| Sugar beets | tons | 17.3 |
| Potatoes | cwt. | 261 |
| Alfalfa seed | lbs. | 630 |
| Mint | lbs. | 59.6 |

Source: 1964 Census of Agriculture.

Livestock production from irrigated land is estimated to be 32 percent of total production. For beef and dairy this amounts to 48 million pounds of beef and 29 million pounds of milk.

*Pasture scene along the upper John Day River near Dayville typifies main agricultural activity of the area. (Grant County Chamber of Commerce)*

## Value of Production

Crop and livestock production associated with irrigation grossed $48 million in sales for 1964. Irrigated crops accounted for over $31 million of the total with livestock and livestock products associated with irrigation making up the remaining value. Important crop categories include fruit, valued at over $8 million; potatoes, nearly $4 million; and forage seed and mint accounting for over $4 million of sales value.

## Economic and Social Impacts

Irrigation is an important production factor for a large segment of agriculture in Subregion 7. Marketing of $48 million in irrigated farm products has a tremendous impact on the subregion.

Irrigation development and expansion have enhanced the economy of the subregion. Many of the business enterprises that existed to serve other basic industries--such as dryland agriculture, cattle ranching, and logging--have expanded to serve irrigated agriculture. The dozen canning and freezing plants located in the northeastern part of the subregion were originally attracted to the area to process dryland green peas. They have since expanded their operation to include a wide variety of irrigated vegetables which accounts for about one-fourth of the value of all vegetable products. The half-dozen fruit processing plants in the northwestern part of the subregion depend heavily on the raw materials from irrigated land. About three-fourths of the fruit, on a value basis, is irrigated. In areas to the east and south irrigated hay and pasture are important parts of the livestock economy. Grass seed, mint, and potatoes are important irrigated crops in the west-central part of the subregion. Presently, only minimum processing facilities are established there for these crops, but a potential exists for expanding potato processing facilities.

In many respects the impact of irrigation on the economy of Subregion 7 is similar to irrigation's impact on the Columbia Basin area in central Washington. The secondary economic impacts of irrigation are based on a multiplier of 2.54 times the value of sales associated with irrigation. This results in about $122 million being generated in the subregion in agriculturally related business and services. Combining the $122 million with the $48 million farm income estimate gives a total of $170 million of irrigation-related revenues.

Employment associated with this revenue is estimated to include about 9,100 farm workers and farm operators and 16,400 workers in allied industries and services--a total of 25,500 people employed because of irrigation. This represents about one third of the total employment in the subregion.

## Use of Water

Irrigation is the largest consumptive user of both surface and ground water throughout the subregion. Irrigation depletions amount to about a million acre-feet annually while other uses consume about 30,000 acre-feet. In some areas, where irrigation development has been accomplished on a project-type basis, diversion records are available. Diversions, shown in tables 104 and 105, are based on available records and estimates of consumptive use and irrigation requirements.

An estimated 2,283,000 acre-feet of water are diverted or pumped for irrigation use annually. An additional 100,000 acre-feet are annually imported from Subregion 3. Diversions include water

Table 104 - Irrigation from Surface Water Sources, 1966, Subregion 7

| Subarea | Adequate Supply Area (acres) | Adequate Supply Diversion (ac-ft) | Inadeq. Supply Area (acres) | Inadeq. Supply Diversion (ac-ft) | Return Flow (ac-ft) | Depletion (ac-ft) |
|---|---|---|---|---|---|---|
| Oregon | | | | | | |
| Walla Walla | 3,000 | 24,000 | 12,800 | 35,000 | 20,000 | 39,000 |
| Umatilla | 31,900 | 206,000 | 22,200 | 45,000 | 102,000 | 149,000 |
| John Day | 17,000 | 76,000 | 53,900 | 206,000 | 130,000 | 152,000 |
| Deschutes | 138,300 | 790,000 | 110,700 | 435,000 | 673,000 | 552,000 |
| Hood | 35,700 | 129,000 | 1,200 | 4,000 | 55,000 | 78,000 |
| Subtotal | 225,900 | 1,225,000 | 200,800 | 725,000 | 980,000 | 970,000 |
| Washington | | | | | | |
| Walla Walla | 4,000 | 19,000 | 28,400 | 76,000 | 32,000 | 63,000 |
| Columbia River | 24,100 1/ | 25,000 | -- | -- | 64,000 | -39,000 |
| Klickitat-White Salmon | 12,800 | 45,000 | -- | -- | 18,000 | 27,000 |
| Subtotal | 40,900 | 89,000 | 28,400 | 76,000 | 114,000 | 51,000 |
| Total | 266,800 | 1,314,000 | 229,200 | 801,000 | 1,094,000 | 1,021,000 |

1/ About 20,000 acres of these lands obtain 100,000 acre-feet of diversion from Subregion 3.

Source: Soil Conservation Service and Bureau of Reclamation data.

delivered to the farms and distribution system losses, as well as operational wastes. System losses are small where water is pumped from the source directly to the farm and large where extensive unlined distribution systems are used.

Farm losses, distribution system losses, and waste amount to about 1,464,000 acre-feet annually. It is estimated that 20 percent of this amount is lost through evapotranspiration on nonirrigated lands, so water actually returning to stream channels or recharging ground water supplies amounts to about 1,171,000 acre-feet annually. About 50,000 acre-feet of the total return flow are from lands in the Kennewick, Washington, area whose source of supply is the Yakima River in Subregion 3. These lands do not deplete Subregion 7's water supply; rather, their return flow contributes to it. Irrigation depletes about 1,112,000 acre-feet of water annually from subregion streams and aquifers.

Table 105 - Irrigation from Ground Water Sources, 1966, Subregion 7

| Subarea | Adequate Supply Area (acres) | Adequate Supply Pumpage (ac-ft) | Inadeq. Supply Area (acres) | Inadeq. Supply Pumpage (ac-ft) | Return Flow (ac-ft) | Depletion (ac-ft) |
|---|---|---|---|---|---|---|
| Oregon | | | | | | |
| Walla Walla | 7,000 | 36,000 | 3,100 | 4,000 | 20,000 | 20,000 |
| Umatilla | 5,100 | 29,000 | 5,400 | 24,000 | 26,000 | 27,000 |
| John Day | 100 | 0 1/ | -- | -- | 0 1/ | 0 1/ |
| Deschutes | 4,800 | 15,000 | 3,000 | 9,000 | 9,000 | 15,000 |
| Hood | -- | -- | 4,300 | 12,000 | 4,000 | 8,000 |
| Subtotal | 17,000 | 80,000 | 15,800 | 49,000 | 59,000 | 70,000 |
| Washington | | | | | | |
| Walla Walla | -- | -- | 6,200 | 9,000 | 4,000 | 5,000 |
| Columbia River | 2,000 | 11,000 | -- | -- | 6,000 | 5,000 |
| Klickitat-White Salmon | 5,000 | 19,000 | -- | -- | 8,000 | 11,000 |
| Subtotal | 7,000 | 30,000 | 6,200 | 9,000 | 18,000 | 21,000 |
| Total | 24,000 | 110,000 | 22,000 | 58,000 | 77,000 | 91,000 |

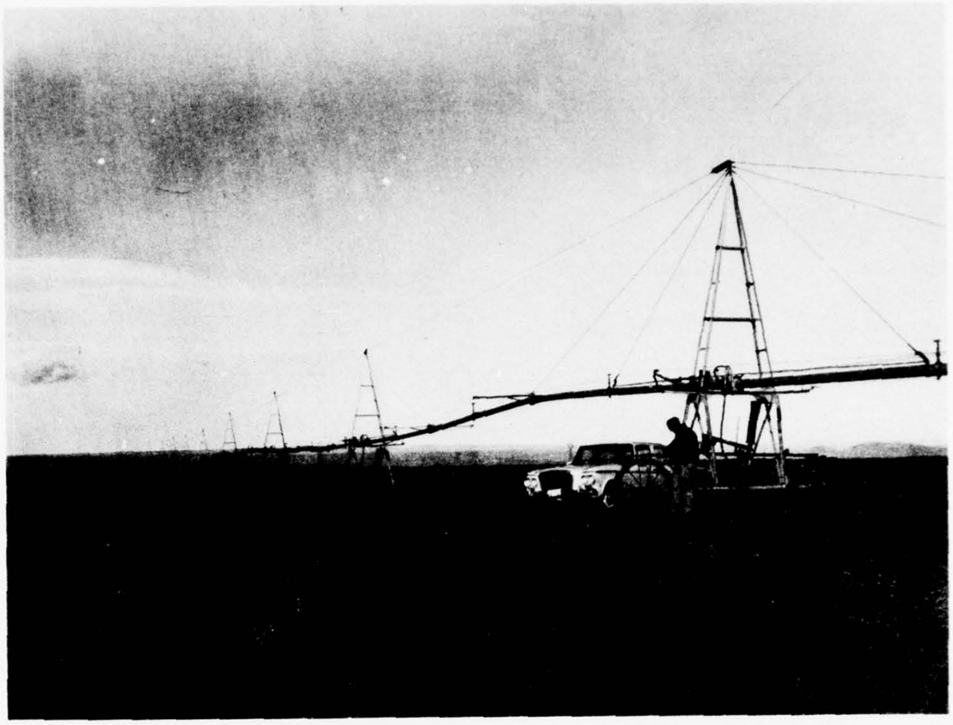
1/ Less than 500 acre-feet
Source: Soil Conservation Service and Bureau of Reclamation data.

## Adequacy of Supply

Nearly half of the irrigated lands in the subregion have inadequate water supplies. Generally, shortages are due to the overappropriation of low summer flows. Some 251,400 acres are subjected to shortages averaging about 297,000 acre-feet annually or about 25 percent of the diversion requirement.

## Application of Water

About three-fourths of the present irrigation is applied by gravity methods. All of the early irrigation was by gravity systems. However, most new systems use sprinklers, and there is increasing changeover from gravity to sprinkler methods on many of the older projects. This changeover is especially notable in the Central Deschutes area where from 20 to 40 percent of the irrigated land has shifted from gravity to sprinkler application within the last decade. Irrigation in the Hood River and The Dalles fruit producing areas is almost exclusively by sprinkler. Adjacent to the Columbia River east of Arlington, Oregon, private developers irrigate almost exclusively by means of automatic self-propelled systems. Wheel-move



*This large automatic move sprinkler irrigation system is being used in the Umatilla area near the Columbia River. (Bureau of Reclamation)*

and automatic sprinkler systems are becoming more common each year, and are replacing both older hand-move sprinklers and gravity systems.

### Quality of Water

The quality of both surface and ground water is good for irrigation throughout the subregion. The mineral content of streams reflects both the semiarid character of the climate and use of water for irrigation. Return flows from irrigated land raise the mineral content of the streams, but not enough to seriously affect their future use for irrigation.

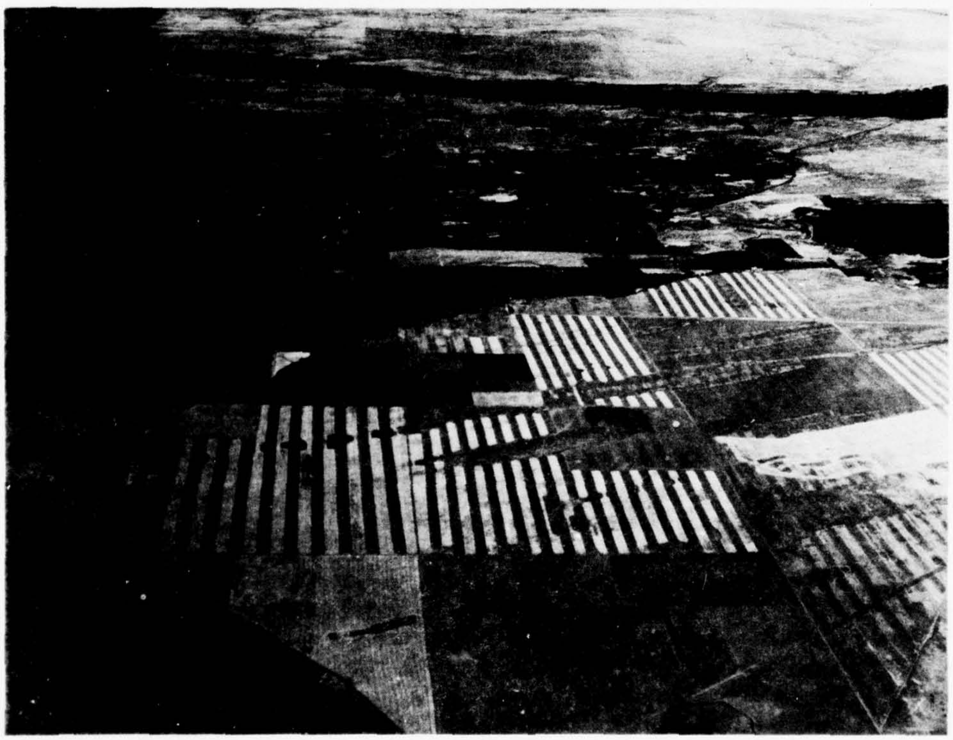
## FUTURE NEEDS

Expansion of irrigation in the subregion will contribute to meeting the region's future food and fiber requirements. The subregion's contribution can be provided by furnishing supplemental water to 251,200 irrigated acres with an inadequate supply and furnishing a full water supply to projected new irrigated farmland.

## Lands

The projections of irrigated acreage and production are based on satisfying future food and fiber needs. Considerations in selecting irrigation needs include availability of land and water, anticipated state, Federal, and private developments and economic and social factors which affect irrigation expansion.

Satisfaction of future needs will require an increase in the irrigated area from 542,000 acres in 1966 to 860,000 acres in 1980, to 950,000 acres in 2000, and 1,220,000 acres in 2020. The development of these figures is presented in table 106. They are based on projected productive irrigated land adjusted to include other irrigated lands not used in the production of crops and pasture. Productive irrigated lands consisting of irrigated cropland harvested and pasture are identified by crop categories in table 107. Satisfaction of needs would require that livestock feed crops consisting of hay, pasture, and small grains continue as the largest users of irrigated land in the subregion.



*Dark irrigation patterns and dry-farmed strip cropped land in the vicinity of Hermiston, Oregon. Columbia River flows across top of photo. (Bureau of Reclamation)*

Table 106 - Irrigated Area Needs by 1980, 2000, and 2020, Subregion 7

| Item | Irrigated Acreage 1980 | 2000 (thousands) | 2020 |
|---|---|---|---|
| Harvested cropland and pasture 1/ | 731 | 808 | 1,037 |
| Other 2/ | 129 | 142 | 183 |
| Total irrigated area | 860 | 950 | 1,220 |

1/ From table 107.
2/ Includes irrigated forest, range, rights-of-way, ditches, roadways, farmsteads, urban, and idle irrigated lands not used in the production of projected crop requirements.

Table 107 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020, Subregion 7

| Crop Category | Acreage Needs 1980 | 2000 (thousands) | 2020 |
|---|---|---|---|
| Small grains | 195 | 181 | 295 |
| All hay | 227 | 269 | 323 |
| Sugar beets | 5 | 8 | 10 |
| Potatoes | 26 | 30 | 34 |
| Vegetables | 15 | 21 | 26 |
| Fruits, nuts, and berries | 23 | 21 | 20 |
| Forage seed, hops, and mint | 45 | 50 | 54 |
| Pasture | 166 | 197 | 235 |
| Unenumerated | 29 | 31 | 40 |
| Total | 731 | 808 | 1,037 |

Generally, acreages of each crop category are projected to increase with the exception of fruits, nuts, and berries. This category, which is virtually all fruit since no significant amount of nuts and berries are grown in the subregion, is projected to decline in needed acreage. The reason for the decline is that yields are projected to increase faster than production requirements. Under these conditions, even though production is projected to increase, it could be produced on fewer acres.

## Production and Yield

A summary of crop production made from irrigated land is presented in table 108.

Table 108 - Crop Production from Projected Irrigated Acreage for 1980, 2000, and 2020, Subregion 7

| Crop Category | Unit | Production 1980 | 2000 (thousands) | 2020 |
|---|---|---|---|---|
| Small grains | tons | 450 | 550 | 1,080 |
| All hay | tons | 730 | 1,050 | 1,490 |
| Sugar beets | tons | 110 | 200 | 260 |
| Potatoes | cwt. | 9,560 | 13,300 | 17,000 |
| Vegetables | cwt. | 1,500 | 2,580 | 4,110 |
| Fruits, nuts, and berries | tons | 130 | 180 | 240 |
| Forage seed, hops, and mint | lbs. | 24,500 | 29,400 | 47,100 |

Crop yields in the form of indexes are presented in figure 39. The indexes are based on 1964 yields equaling 100. Fairly substantial yield increases are projected for all crop categories.

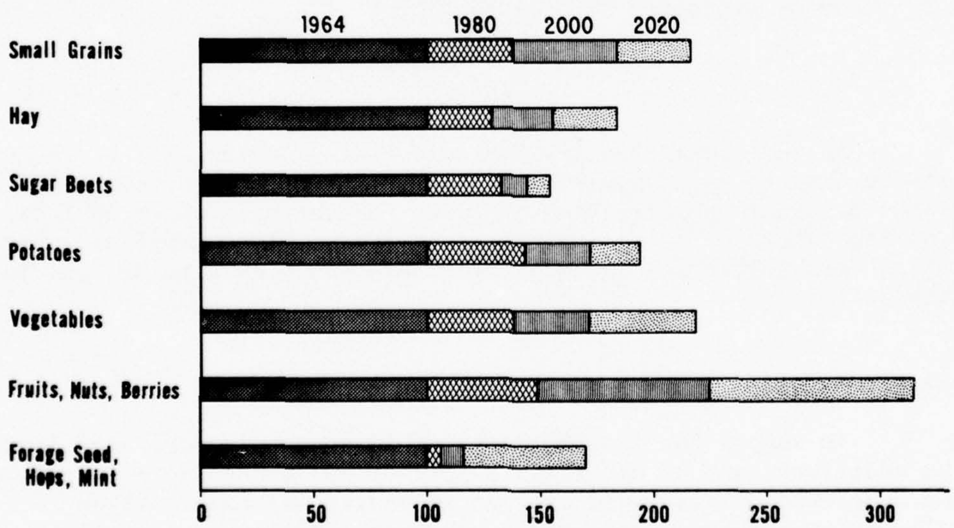



FIGURE 39. Projected Crop Yields for 1980, 2000, and 2020 (1964 Yield Equals Base of 100).

## Value of Production

The Office of Business Economics and the Economic Research Service (OBERS) established a future price structure for use in the Regional projections. The value of irrigated crop production for Subregion 7 was estimated using this future price structure. These values include irrigated crops fed to livestock except for pasture; no estimates were made for the latter. Table 109 presents a summary of these projected values for the three study years.

Table 109 - Value of Projected Irrigated Crop Production, Subregion 7

| Crop Category | Value of Production 1/ | | |
|---|---|---|---|
| | 1980 | 2000 ($1000) | 2020 |
| Small grains | 23,900 | 29,300 | 57,000 |
| Hay | 15,800 | 22,500 | 32,000 |
| Dry beans and peas | -- | -- | -- |
| Sugar beets | 1,300 | 2,300 | 3,000 |
| Potatoes | 12,800 | 17,800 | 22,800 |
| Vegetables | 4,400 | 7,700 | 12,200 |
| Fruits, nuts, and berries | 15,800 | 21,600 | 28,900 |
| Forage seed, hops, and mint | 5,100 | 6,100 | 9,800 |
| Total | 79,100 | 107,300 | 165,700 |

1/ Based on projected normalized prices

## Water

An additional 2.6 million acre-feet of water will be required at the farm to meet supplemental and full supply requirements of lands needed to be irrigated by 2020. Depletions resulting from the new water supply will total about 1.8 million acre-feet. Estimated farm deliveries and depletions are shown by time periods in table 110.

### Supplemental

To supply the 251,200 acres of inadequately irrigated land, an additional annual diversion supply of 297,000 acre-feet needs to be developed. This would provide an additional farm delivery of 235,000 acre-feet and result in additional depletions of 158,000 acre-feet. It is estimated that about one-third of the supplemental

Table 110 - Projected Farm Deliveries and Depletions, Subregion 7

| Year | Presently Irrigated Farm Delivery | Presently Irrigated Depletion | Future Irrigation Farm Delivery | Future Irrigation Depletion | Total Farm Delivery | Total Depletion |
|---|---|---|---|---|---|---|
| | | | (1,000 ac-ft) | | | |
| 1966 | 1,605 | 1,112 | | | 1,605 | 1,112 |
| 1980 | 1,680 | 1,170 | 1,110 | 760 | 2,790 | 1,930 |
| 2000 | 1,760 | 1,270 | 1,430 | 980 | 3,190 | 2,200 |
| 2020 | 1,840 | 1,270 | 2,400 | 1,680 | 4,240 | 2,950 |

need can be met by 1980 and the remainder can be met by 2020. Estimated supplemental water requirements are shown by subarea in table 111.

Table 111 - Supplemental Irrigation Diversion Requirements, Subregion 7

| Subarea | Water-short lands (acres) | Supplemental Requirement (acre-feet) |
|---|---|---|
| Oregon | | |
| Walla Walla | 15,900 | 41,000 |
| Umatilla | 27,600 | 73,000 |
| John Day | 53,900 | 35,000 |
| Deschutes | 113,700 | 70,000 |
| Hood River | 5,500 | 6,000 |
| Subtotal | 216,600 | 225,000 |
| Washington | | |
| Walla Walla | 34,600 | 72,000 |
| Columbia River | -- | -- |
| Klickitat-White Salmon | -- | -- |
| Subtotal | 34,600 | 72,000 |
| Total | 251,200 | 297,000 |

Full

The estimated farm delivery requirement and use (depletion) vary throughout the subregion. Lower lands along the Columbia River generally have the highest water requirements. However, low lands

in the White Salmon-Klickitat and Hood subareas have low requirements because they are located in the Columbia River Gorge and their climate is similar to the more moist, marine-type climate prevalent in subregions to the west. Requirements are lowest in the upper portions of the Deschutes and John Day subareas. Several of the subareas have been subdivided, as shown by the dash lines on figure 36, to reflect significant variations in climate and estimated crop requirements. Table 112 presents representative projected needs of water for irrigation in each subarea for future developments.

Table 112 - Irrigation Requirements and Depletions, Subregion 7

| Subarea | 1966-2000 Farm Delivery | 1966-2000 Depletion | 2000-2020 Farm Delivery | 2000-2020 Depletion |
|---|---|---|---|---|
| | (all figures are acre-feet per acre) | | | |
| Walla Walla | 3.8 | 2.6 | 3.7 | 2.7 |
| Umatilla (east) | 3.7 | 2.5 | 3.7 | 2.7 |
| Umatilla (west) | 4.0 | 2.9 | 4.5 | 3.3 |
| Columbia River | 3.3 | 2.6 | 3.7 | 2.7 |
| John Day (upper) | 3.8 | 2.4 | 3.2 | 2.4 |
| John Day (lower) | 4.0 | 2.5 | 3.5 | 2.6 |
| Deschutes (upper) | 2.8 | 1.8 | 2.8 | 2.1 |
| Deschutes (central) | 3.4 | 2.2 | 3.1 | 2.3 |
| Deschutes (lower) | 3.6 | 2.5 | 3.2 | 2.4 |
| Hood (east) | 3.6 | 2.5 | 4.8 | 3.5 |
| Hood (west) | 2.8 | 2.1 | 3.4 | 2.5 |
| White Salmon-Klickitat | 2.8 | 2.1 | 3.4 | 2.5 |

The 680,000 acres of presently dry lands projected to be irrigated by 2020, (from 542,000 in 1966 to 1,220,000 in 2020) will require a full water supply. Required farm deliveries for this acreage will total about 2.4 million acre-feet and depletions will amount to 1.7 million acre-feet annually. The increasing requirements by time periods are shown for future irrigation in table 110.

## THE POTENTIAL TO MEET THE NEEDS

More than 10 times the acreage currently irrigated is suitable for irrigation. The subregion has an adequate supply of water from the Columbia River, the other major streams, and ground water to satisfy projected irrigation needs for 2020. With abundant land and water resources, irrigated agricultural output of Subregion 7 will expand considerably.

## Potentially Irrigable Lands

The potentially irrigable land in Subregion 7 is estimated to total about 5,700,000 acres or about 17 percent of the total potentially irrigable land in the Columbia-North Pacific Region. Included in this figure are private and public lands in both agricultural and nonagricultural use, including some forest lands.

Potentially irrigable lands have been classified into three land classes as shown in table 113. The general location of these lands is shown on figure 40. A brief summary of the characteristics of each land class follows.

Table 113 - Potentially Irrigable Acreage, Subregion 7

| Subarea | Class 1 | Class 2 | Class 3 | Total |
|---|---|---|---|---|
| | | (acres) | | |
| Walla Walla | 19,000 | 26,000 | 33,000 | 78,000 |
| Umatilla | 211,600 | 651,300 | 523,400 | 1,386,300 |
| John Day | 39,400 | 619,100 | 374,100 | 1,032,600 |
| Deschutes | 53,900 | 454,000 | 974,600 | 1,482,500 |
| Hood | 4,800 | 120,700 | 75,600 | 201,100 |
| Oregon total | 328,700 | 1,871,100 | 1,980,700 | 4,180,500 |
| Walla Walla | 80,500 | 96,300 | 353,600 | 580,400 |
| Columbia River | 272,900 | 298,800 | 43,800 | 615,500 |
| Klickitat-White Salmon | 10,300 | 94,200 | 294,300 | 398,800 |
| Washington total | 363,700 | 489,300 | 691,700 | 1,544,700 |
| Subregion total | 692,400 | 2,360,400 | 2,672,400 | 5,725,200 |

Source: Acreages prepared by the Bureau of Reclamation based on State of Oregon, Department of Agriculture, and Department of the Interior data.

### Class 1

The 692,000 acres of class 1 lands make up about 12 percent of the potentially irrigable area. They are highly productive and capable of producing the highest income crops. However, the potential crop range varies greatly because of climatic variations. Cropping varies from grass pasture and alfalfa in the Deschutes subarea to apples and cherries in the Hood subarea near the Columbia River. Practically all of the class 1 lands are located in the better

climatic zones for irrigation productivity. This combination affords maximum flexibility in crop selection.

Most of the soils have formed from windblown materials, although some have developed on alluvial terraces and fans. They are deep, friable, medium textured soils. Generally, soil colors are darker in the mountains where precipitation is fairly high, and lighter in the low rainfall areas. The topography may be rolling, but with slopes of less than 5 percent. With few exceptions, lands are suitable for gravity irrigation; there are no limitations for sprinkler irrigation. Surface and subsurface drainage is very good.

Class 2

About 2,360,000 acres, some 41 percent of the potentially irrigable lands, are class 2. Good yields of most climatically adapted crops can be expected with irrigation.

Origin of soils varies throughout the subareas. Some have developed from alluvial or colluvial deposits, others have developed in place from existing parent materials. For the most part, they are derived from windlaid materials which have been deposited over most of the subregion, both in Oregon and Washington.

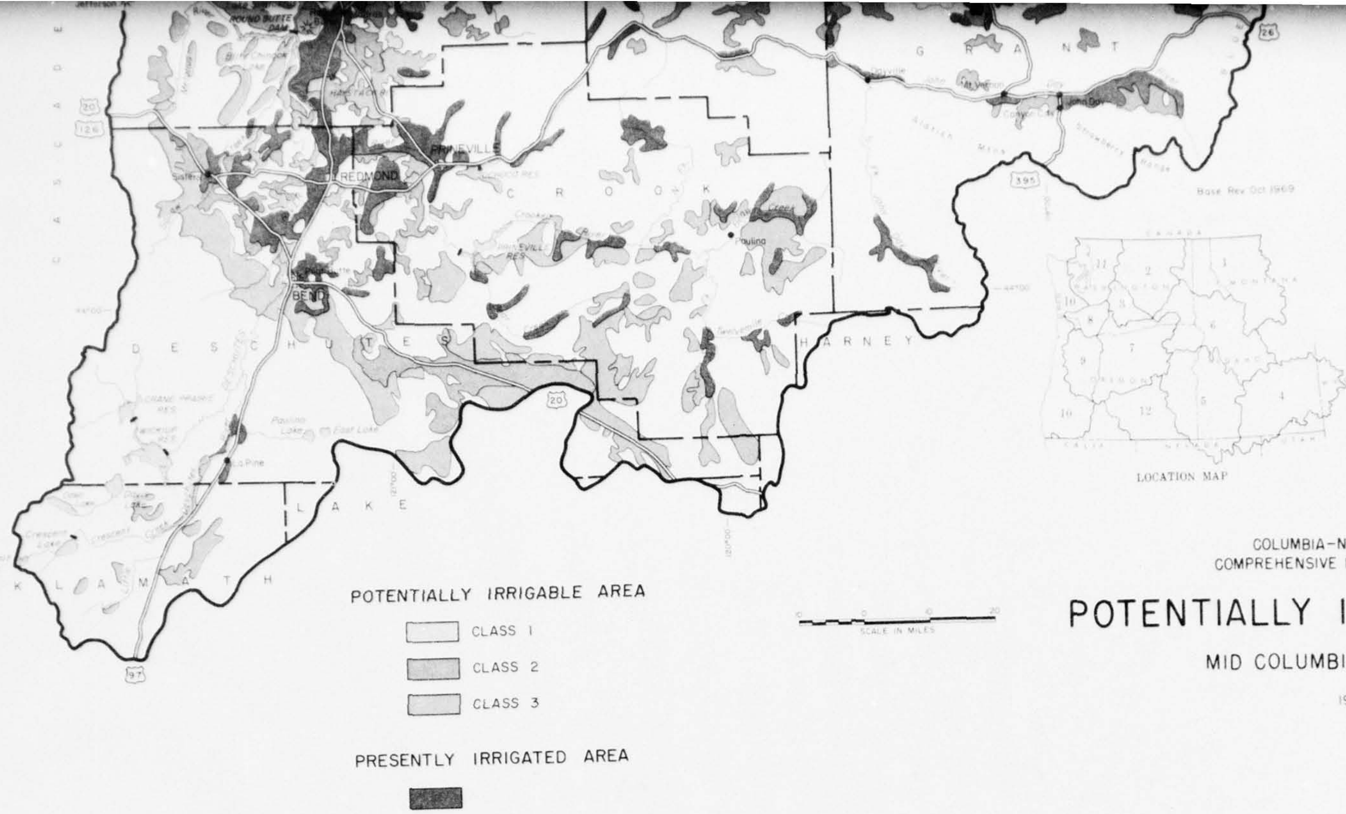
Some of the lands are class 2 because of shallow soils and others because of slope. Most of the windlaid soils have class 1 texture but have slopes greater than 5 percent. They range in texture from silt loam to sandy loam. A small percentage of the class 2 lands have soil textures too coarse or too fine for ideal irrigation farming or have some gravels or rocks in the profile. Only minor drainage problems are likely to develop with irrigation. However, they can be prevented or corrected at moderate cost.

Class 3

There are 2,672,000 acres of class 3 lands, 47 percent of the potentially irrigable area. The crop range of these lands is somewhat limited under irrigation. The most common irrigated crops will be hay and pasture, but grains, potatoes, and other specialty crops may also be grown in the better climatic zones. Present dry-land use is almost exclusively for grains or grazing.

Some of the potentially irrigable class 3 soils have formed in place from existing parent materials and some from old alluvial deposits. Others are windlaid and are class 3 because of excessive slope, coarse texture, shallow depth, or presence of rock outcrops. In almost all cases the parent material is of volcanic origin.

SKAMANIA
KLICKITAT
WASHINGTON
OREGON
HOOD RIVER
THE DALLES
THE DALLES DAM
JOHN DAY DAM
SHERMAN
GILLIAM
MORROW
UMATILLA
PENDLETON
McKAY RES
BENTON
KENNEWICK
McNARY DAM
WALLA WALLA
COLUMBIA
WASCO
JEFFERSON
WHEELER
GRANT
CROOK
PRINEVILLE
REDMOND
BEND
DESCHUTES
HARNEY
PELTON DAM
ROUND BUTTE DAM
CRANE PRAIRIE RES
CASCADE RANGE
Condon
Arlington
Dayton
Waitsburg
Base Rev Oct 1969




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# POTENTIALLY IRRIGABLE AREA

MID COLUMBIA, SUBREGION 7

1968

FIGURE 40

Texture ranges from loamy sand to clay loam but also includes fine sands and clays. Topography varies from smooth (waterlaid deposits along streams and old lake bottoms) to complex rolling slopes (windlaid areas along the Columbia River) which may have slopes over 20 percent.

With the exception of some local low areas where salt problems may develop, surface and subsurface drainage is inherently good.

One of the most serious limitations of class 3 lands is the erosion hazard. In many areas wind erosion is the greatest problem. Water erosion also could be a problem, especially on the steeper slopes along the Columbia River.

## Water Supply

Average inflow to the subregion is about 119 million acre-feet and outflow is 129 million acre-feet. Thus, net discharge originating within the subregion amounts to some 10 million acre-feet annually. Although there is an abundant surface water supply, most of it is readily available only to lands near the Columbia River. New storage will be needed on some tributary streams to meet present and anticipated needs.

There are an estimated 47 million acre-feet of ground water in the uppermost 50 to 100 feet below the water table. Net annual recharge is probably 10 or 11 million acre-feet per year. Much of the ground water supply is not readily available however, because of excessive depths to the water table and low permeabilities of some aquifers. Well yields between 500 and 2000 gallons per minute have been attained in some areas. However, two such areas, one near The Dalles, the other near Ordnance, Oregon, have been declared critical ground water areas because of excessive pumping.

## Potential Developments

In order to meet the long-range irrigated acreage needs, a dependable water supply for an additional 680,000 acres will have to be developed by 2020. In addition, 251,200 presently irrigated acres which have an inadequate water supply must be provided a full supply. The subregion has enough good quality water and land to accomplish this task. It is anticipated that the combined efforts of private initiative and state and Federal interests will develop the required water and land resources.

It is possible for irrigation development in Subregion 7 to far exceed the projected 2020 development needs. The potential of

the subregion is virtually untapped. An abundance of high quality land and water in conjunction with favorable growing climate make the area adjacent to the Columbia River extremely attractive for extensive development. Well over a million potentially irrigable acres are situated where water can be made readily available.

## Developments by Subarea

Each subarea has potentially irrigable lands and a water supply to develop them. Some of the future expansion will occur on the fringes of existing irrigated areas, but most of it will come from development of the extensive dry grain and range areas. Large blocks of this type of arable land are located in the Walla Walla, Umatilla, Columbia River, and John Day subareas near the Columbia River in both Washington and Oregon.

The Deschutes subarea presently has the most extensive irrigation development in the subregion. With additional development of the water supply, a major expansion of irrigated acreage can occur. Possible sources of additional water under study include various water savings programs and construction of new reservoirs.

New development in some higher portions of the subareas will be limited because of a lack of water.

## Private Developments

Most of the subregion's presently irrigated lands have been developed through privately financed projects. Early development began through diversion of natural flows, construction of storage facilities, and by pumping from Federally constructed storage facilities and ground water.

Individual water users and corporate developments will make a definite contribution to the growth of irrigation development in the future. In several subareas the possibilities for additional private irrigation development are numerous. Much of the anticipated development by individual effort will take place in areas where farmers can obtain a reliable ground water supply; some could be developed by pumping the natural flows of the smaller streams which have not been overappropriated. In many cases new stored water will be used to supplement present supplies as well as to provide water for additional acreage.

There are a number of plans for large-scale corporate developments in the subregion. Currently there are four proposals to pump water from the John Day Reservoir pool on the Oregon side of the

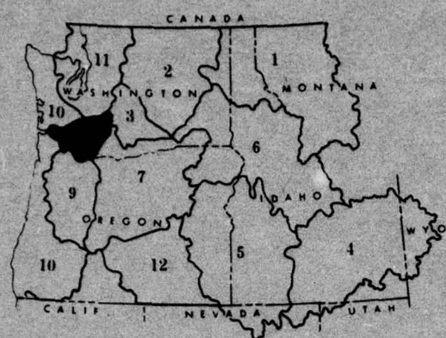
Columbia River. Two of these would irrigate some 25,000 acres south of Interstate 80N between Boardman and Hermiston in the Umatilla subarea. The other two would provide development of a 47,000-acre unit near Wasco in northern Sherman County (John Day subarea), and development of a 25,000-acre unit near Arlington in northern Gilliam County (Umatilla subarea). These along with other developments being planned could irrigate over 300,000 acres by pumping from the Columbia River.

## Federal Developments

There is currently a number of investigations completed or underway by Federal agencies for multiple-purpose projects. These developments could provide a full water supply for roughly a million acres of new land and a supplemental water supply for a quarter million acres. However, a considerable number of the Federal proposals--particularly those areas close to readily available water sources--is expected to be developed by individuals or corporations. The water supply required for Federal developments will come from multiple-purpose reservoirs on rivers and streams in the proposed area being developed; in several areas the supply will be supplemented by pumping from the Columbia River.

Storage sites have been identified on several rivers and many smaller streams. Some of the larger multiple-purpose storage sites are located on the Walla Walla, Touchet, and Umatilla Rivers in the Walla Walla and Umatilla subareas. Numerous small multiple-purpose developments on upper tributaries where dams could be built to store water for small, localized units of land have also been studied. In some areas irrigation expansion will take place primarily from water savings through the more efficient use of existing supplies.

The Deschutes, Hood, and White Salmon-Klickitat subareas have already been more intensively developed for irrigated farming than the other subareas of the subregion. Major expansion of the project-type irrigation is possible only if adequate water supplies can be developed. Water sources under study in these areas include water savings resulting from lining the lengthy distribution canals and construction of new reservoirs on streams that have their headwaters on the eastern slope of the Cascades. Little individual expansion of irrigation is expected in these subareas because the expense and difficulty of developing additional water supplies demand cooperative project effort.




LOCATION MAP

# SUBREGION 8

# SUBREGION 8

# LOWER COLUMBIA

## THE SETTING

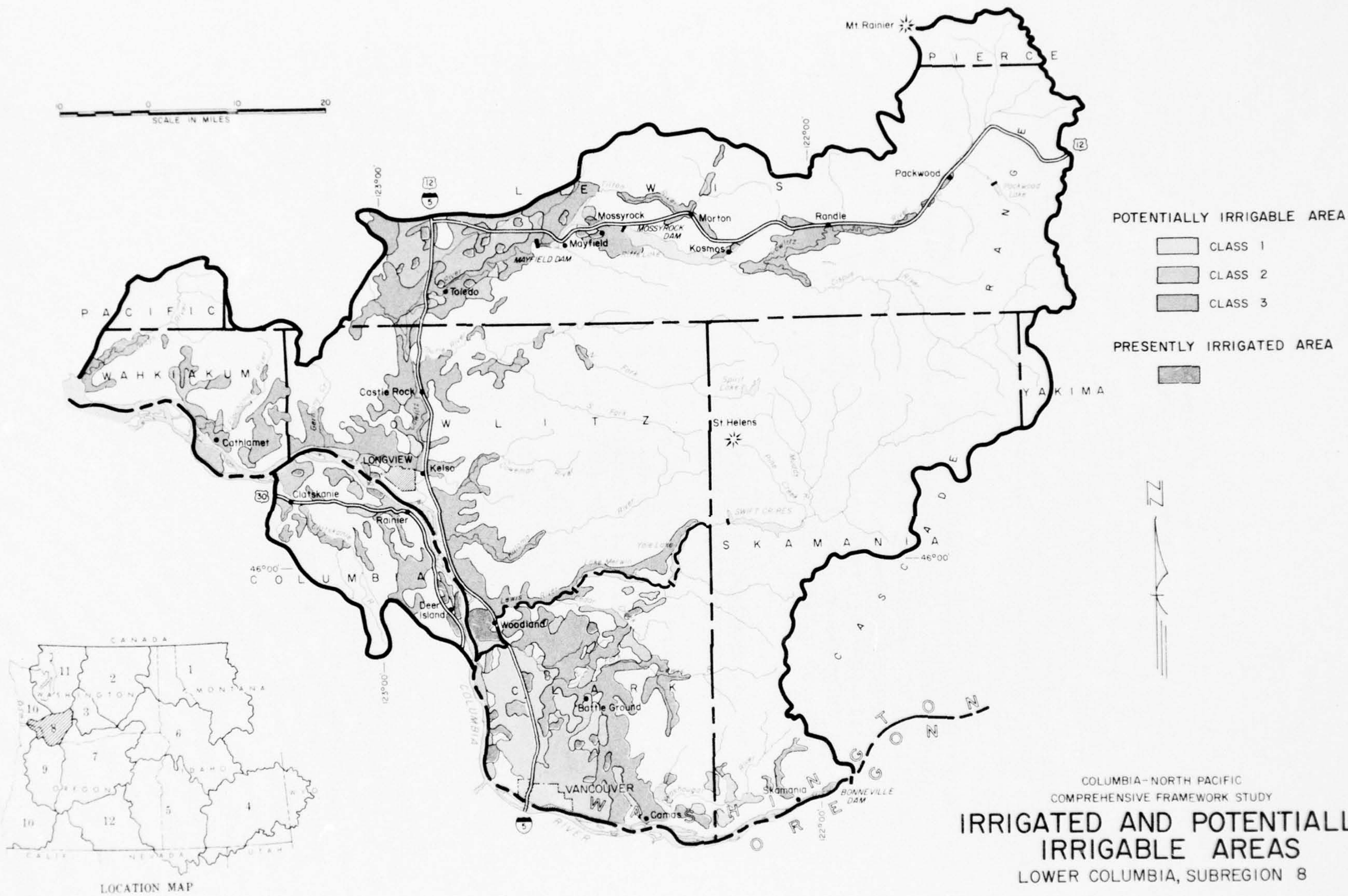
The Lower Columbia Subregion, the smallest of the Columbia-North Pacific Subregions, is located in Washington and Oregon. About 94 percent of its more than 3.25 million acres lie in Washington. The drainage basins of all Washington streams tributary to the Columbia west of the Cascades and the Clatskanie River and other smaller streams in Oregon form a roughly triangular-shaped subregion as shown on figure 41.

The area has a rather uniform temperate marine climate characterized by mild, wet winters and warm, rather dry summers with differences in elevation accounting for local variations in temperatures and precipitation amounts. Temperature ranges are moderate, reflecting the marine influence. The warm summers are favorable for agricultural production with growing season of from 180 to 220 days depending on elevation. Generally, less than 10 percent and frequently less than 5 percent of the annual precipitation occurs during July and August when needed most for sustaining crop growth.

The wet winters result in large snowfields in the mountainous portion, thus helping to sustain natural streamflows during the summer months.

The largest stream is the Cowlitz River which contributes about one-half of the annual runoff from the subregion to the Columbia River. The Lewis River is the second largest stream; the smaller streams include the Clatskanie, Kalama, Washougal, Coweman, Elockoman and East Fork of Lewis River. The streams in the Oregon portion contribute only a small percentage of the annual runoff. The combined annual runoff of the subregion's streams is about 18 million acre-feet.

The predominant landforms are the majestic peaks, Mount Rainier, Mount Adams and Mount Saint Helens, in the Cascade Range. The eastern portion of the subregion is characterized by the more rugged topography of this range; the western portion consists of rolling hills and narrow stream valleys. The rolling benchlands and river bottom lands of the valleys occupy only a small percentage of the total land area. The majority of the level lands are located along the lower Lewis, Cowlitz, and Columbia Rivers.




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# IRRIGATED AND POTENTIALLY IRRIGABLE AREAS

LOWER COLUMBIA, SUBREGION 8

1968

FIGURE 41

Early settlement occurred in conjunction with the occupancy of the Willamette Valley in Oregon. Fort Vancouver was the earliest trade center and the hub of economic development. Agriculture was well established by 1830 and spread outward from this post to much of the surrounding area. The lands were heavily forested at the time of settlement and economic development consisted primarily of lumbering and conversion of the cutover lands to agricultural use. This practice continues on a limited basis.

Agriculture is one of the basic economic activities and is important in the lower valleys. It is characterized by production of dairy and poultry products, meat, and truck crops to support the urban concentrations. Many small noncommercial farms do not produce for market. Meat packing plants, fruit and vegetable canneries, and creameries serve both local and regional cities and towns. An excellent transportation network provides for the rapid movement of the goods and services within the subregion.

More than 240,000 people live in the subregion; a density of about 25 people per square mile. Principal cities are Vancouver, Longview, and Kelso, all in Washington.

## PRESENT STATUS

The principal use of irrigation is for agriculture, although there is limited use by nurseries, recreation areas, and some cropland for feed and cover for wildlife.

In 1966 there were about 18,000 acres irrigated. Of this amount about 16,000 acres were in Washington; the largest concentration was located west of Woodland, with smaller areas scattered mostly throughout the lowlands near Vancouver and along the lower Cowlitz River. The remaining 2,000 acres were located in Oregon along the Columbia River near Deer Island, Rainier, and Clatskanie. All of the irrigation development has been by private means; there are no large project-type developments. Figure 41 shows the location of the irrigated lands.

Data for the irrigated area, irrigated crops produced, and the value of irrigated production were derived in part from the 1964 Census of Agriculture. The counties of Clark, Cowlitz, Lewis, Skamania, and Wahkiakum in Washington and Columbia County in Oregon provide the data for these studies.

### Characteristics of Irrigated Areas

Although the area is not a major producer of agricultural products within the region, the production of livestock and livestock

products, potatoes, mint oil, berries, and some vegetables are important locally and exceed the needs of the subregion.

*Irrigation during the dry summer months promotes optimum plant growth. (Bureau of Reclamation)*

About three-fourths of the irrigated acreage is in pasture, hay, silage, and small grains. Based on irrigated land use and other census data, dairy and other livestock farms constitute the majority of farms with irrigated land. Berry, vegetable, and field crop farms constitute most of the remaining farm types having irrigated cropland. Figure 42 presents irrigated land use and the percentage distribution of this use for harvested cropland and pasture.

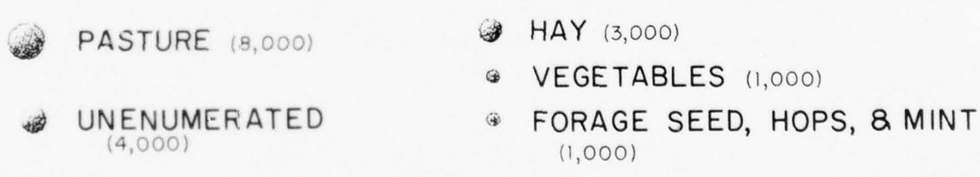



FIGURE 42. Irrigated Acreage of Cropland Harvested and Pasture, 1964, Subregion 8.

In 1964 there were about 550 farms with irrigated land; this number represents about 8 percent of the subregion's 7,200 farms. The average farm with irrigated land had about 30 acres irrigated.

## Production of Irrigated Crops

Production of irrigated crops is compared with total production by crop category in table 114. Yields of selected irrigated crops follow in table 115. It is evident that irrigation is not as significant a factor of production in Subregion 8 as in most other subregions in the Columbia-North Pacific Region. However, irrigation is important as insurance against dry periods especially for the vegetable crops. Also, for those vegetables going to processing plants, premiums are paid for quality products that often can only be realized with irrigation.

Table 114 - Summary of Crop Production, 1964, Subregion 8

| Crop Category | Units | Production Total (1000's) | Production Irrigated (1000's) | Percent Total |
|---|---|---|---|---|
| Small grains | tons | 9 | - | 0.0 |
| All hay | tons | 184 | 4 | 2.2 |
| Potatoes | cwt. | 143 | 28 | 19.6 |
| Vegetables | cwt. | 284 | 105 | 37.0 |
| Fruits, nuts, and berries | tons | 10 | 1 | 10.0 |
| Forage seed, hops, and mint | lbs. | 228 | 48 | 21.1 |

Source: Derived from Census of Agriculture and Agricultural Statistics.

## Value of Production

The total value of crops, livestock, and livestock products associated with irrigation amounted to just over $2 million in 1964. Vegetable crops accounted for nearly $1 million of the total. These estimates of value were made at the farm level and do not include value added from processing.

## Economic and Social Impacts

Irrigation has favorably enhanced the value of agriculture in the subregion. The gross value of products and services derived from

Table 115 - Yields of Selected Major Irrigated Crops, 1964, Subregion 8

| Crop | Units | Yield per Irrigated Acre |
|---|---|---|
| Forage | | |
| Alfalfa | tons | 2.6 |
| Clover | tons | 2.1 |
| Field crops | | |
| Potatoes | cwt. | 248 |
| Mint oil | lbs. | 46 |
| Vegetables | | |
| Snap beans | cwt. | 150 1/ |
| Carrots | cwt. | 184 1/ |
| Lettuce | cwt. | 220 1/ |

1/ Estimated from Washington Agricultural Statistics - Vegetable Crops 1964.

irrigated farms is shown in table 116. It is estimated that irrigation use has greatly enhanced the processing and trades and services industries and has added economic values almost double the value of sales of agricultural products.

The enhanced agricultural production has generated employment in the processing and trades and services industries to nearly double the man-years of employment engaged in basic agriculture. In 1964 employment provided by irrigated agriculture was estimated to be 390 man-years, of which 150 were on the farm, 40 were in processing agricultural products, and 200 man-years of employment were provided in trades and services.

Table 116 - Gross Value of Agricultural Products and Services Associated with Irrigation Use, Subregion 8

| Industry | Gross Value (1,000,000) |
|---|---|
| Basic Agriculture | $2.1 |
| Processing | 1.7 |
| Trades and services | 3.3 |
| Total | $7.1 |

## Use of Water

Most of the irrigation water supply comes from small unregulated streams and from ground water sources. There is some pumping from the Columbia River to serve lands that have been reclaimed by drainage and diking, such as near the mouth of the Clatskanie River.

The Cowlitz and Lewis Rivers each have several large storage reservoirs that are used primarily for hydroelectric power generation. However, they are not used as sources of irrigation water supplies. Estimated average water use is summarized for surface and ground water in tables 117 and 118.

Table 117 - Irrigation from Surface Water Sources, 1966, Subregion 8

| States | Adequate Supply Area (acres) | Adequate Supply Diversion (ac-ft) | Inadeq. Supply Area (acres) | Inadeq. Supply Diversion (ac-ft) | Return Flow (ac-ft) | Depletion (ac-ft) |
|---|---|---|---|---|---|---|
| Oregon | 2,000 | 3,000 | - | - | 1,000 | 2,000 |
| Washington | 11,500 | 20,000 | - | - | 7,000 | 13,000 |
| Total | 13,500 | 23,000 | - | - | 8,000 | 15,000 |

Source: Soil Conservation Service and Bureau of Reclamation data.

Table 118 - Irrigation from Ground Water Sources, 1966, Subregion 8

| States | Adequate Supply Area (acres) | Adequate Supply Diversion (ac-ft) | Inadeq. Supply Area (acres) | Inadeq. Supply Diversion (ac-ft) | Return Flow (ac-ft) | Depletion (ac-ft) |
|---|---|---|---|---|---|---|
| Oregon | - | - | - | - | - | - |
| Washington | 4,500 | 7,000 | - | - | 2,000 | 5,000 |
| Total | 4,500 | 7,000 | - | - | 2,000 | 5,000 |

Source: Soil Conservation Service and Bureau of Reclamation data.

Water use varies from year to year in this area depending on the amount of precipitation received during the growing season. In many instances, irrigation is used to prevent crop failure and to maintain plant growth rather than to produce optimum yields. In years when precipitation is low, the amount of water applied per

AD-A036 554 PACIFIC NORTHWEST RIVER BASINS COMMISSION VANCOUVER WASH F/G 8/6
COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
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acre is somewhat greater than i
cial farms, which comprise near
not used as intensively as on c

Based on current practic
30,000 acre-feet of water are d
About 23,000 acre-feet are dive
the remaining 7,000 acre-feet c
is used for irrigation in the s

Loss and waste are estim
annually. Between the farm and
sumed nonbeneficially so that t
stream channels or ground water
acre-feet annually. Thus, the
It is estimated that 15,000 acr
5,000 acre-feet is ground water

Adequacy

Water supplies are adequ
gation. However, present use i
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would be about 40,000 acre-feet

Applicati

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is best suited to the rolling t
agricultural lands. The water
ground water sources into the f

The most common type of
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crops such as pole beans and or
on small irregularly-shaped acr

Qualit

In general, both surfac
quality for irrigation. Irrig
quality of water supplies. In
into northern Cowlitz County,
wells operating within the gra
However, deeper wells tapping
beds encounter saline and iron

small amounts of water and are generally unsuitable for irrigation use.

## FUTURE NEEDS

About 82,000 acres of new irrigation development is needed by 2020 if Subregion 8 is to meet its share of the Region's food and fiber requirement. This represents an increase of 5 times the present irrigated acreage. Nearly half of this development is needed by 1980. To provide a full water supply to new lands would require an additional depletion to the Region's water supply of 63,000, 78,000 and 132,000 acre-feet annually by 1980, 2000 and 2020 respectively.

### Lands

The projections of irrigated acreage are based on satisfying future food and fiber requirements. Consideration was also given to availability of land and water. Available land for agriculture in Subregion 8 is expected to be conditioned by future urban expansion. Table 119 summarizes the projected irrigated area needs. These acreages include all irrigated land whether or not it is used for crop production and pasture.

Table 119 - Irrigated Area Needs by 1980, 2000, and 2020, Subregion 8

| Item | Irrigated Acreage | | |
|---|---|---|---|
| | 1980 | 2000 (1000's) | 2020 |
| Harvested cropland and pasture 1/ | 51 | 60 | 85 |
| Other 2/ | 9 | 10 | 15 |
| Total irrigated area | 60 | 70 | 100 |

1/ From table 120.
2/ Includes irrigated forest, range, rights-of-way, ditches, roadways, farmsteads, urban, and idle irrigated lands not used in the production of projected crop requirements.

Irrigated cropland harvested and pasture needs are presented by crop category in table 120. Irrigated forage production, though not important in 1964, is projected to become the largest user of irrigated land. This is primarily due to the increasing need for dairy products to satisfy the demands of an expanding urban population.

Table 120 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020, Subregion 8

| Crop Category | Acreage Needs 1980 | 2000 | 2020 |
|---|---|---|---|
| | | (1000's) | |
| Small grains | 3 | 2 | 3 |
| All hay | 7 | 29 | 41 |
| Dry beans and peas | - | - | - |
| Sugar beets | - | - | - |
| Potatoes | 2 | 1 | 1 |
| Vegetables | 5 | 3 | 5 |
| Fruits, nuts, and berries | 3 | 2 | 3 |
| Forage seed, hops, and mint | 7 | 4 | 6 |
| Pasture | 17 | 10 | 13 |
| Unenumerated | 7 | 9 | 13 |
| Total | 51 | 60 | 85 |

## Production and Yield

A summary of crop production from irrigated land is presented in table 121.

Table 121 - Crop Production from Projected Irrigated Acreage for 1980, 2000, and 2020, Subregion 8

| Crop Category | Unit | Production 1980 | 2000 | 2020 |
|---|---|---|---|---|
| | | | (1000's) | |
| Small grain | tons | 5 | 5 | 8 |
| Hay | tons | 21 | 11 | 176 |
| Potatoes | cwt. | 702 | 422 | 477 |
| Vegetables | cwt. | 629 | 502 | 1,041 |
| Fruits, nuts, and berries | tons | 13 | 12 | 26 |
| Forage seed, hops, and mint | lbs. | 454 | 312 | 596 |

Crop yields in the form of indexes are shown in figure 43. The indexes represent percentage increases in yield over the 1964 level which was set at a base of 100. Even though fairly large increases in yields are projected, Subregion 8 is not expected to be a large producing area due to restricted availability of land.

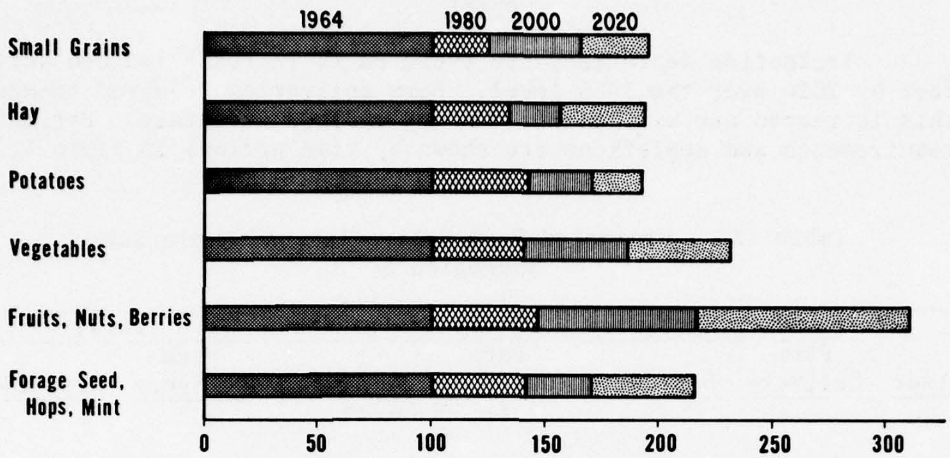



FIGURE 43. Selected Crop Yields for 1980, 2000, and 2020 (1964 as Base Year Equals 100), Subregion 8.

Value of Production

Values of irrigated crop production were estimated using the future price structure established by the Office of Business Economics and the Economic Research Service (OBERS) in the Regional projections. These values include irrigated crops fed to livestock with the exception of pasture for which no estimates were made. Table 122 contains a summary of projected values.

Table 122 - Value of Projected Irrigated Crop Production, Subregion 8

| Crop Category | Value of Production 1/ 1980 | 2000 | 2020 |
|---|---|---|---|
| | | ($1,000) | |
| Small grains | 300 | 300 | 400 |
| Hay | 500 | 200 | 3,800 |
| Dry beans and peas | - | - | - |
| Sugar beets | - | - | - |
| Potatoes | 900 | 600 | 600 |
| Vegetables | 1,900 | 1,500 | 3,100 |
| Fruits, nuts, and berries | 1,600 | 1,400 | 3,100 |
| Forage seed, hops, and mint | 100 | 100 | 100 |
| Total | 5,300 | 4,100 | 11,100 |

1/ Based on projected normalized prices.

## Water

Irrigation depletions are expected to increase 140,000 acre-feet by 2020 over the 1966 level. Farm deliveries required to meet this increased use will increase about 193,000 acre-feet. Estimated requirements and depletions are shown by time periods in table 123.

Table 123 - Projected Farm Deliveries and Depletions, Subregion 8

| | Presently Irrigated | | Future Irrigation | | Total | |
|---|---|---|---|---|---|---|
| Year | Farm Delivery | Depletion | Farm Delivery | Depletion | Farm Delivery | Depletion |
| | | | (1,000 ac-ft) | | | |
| 1966 | 27 | 20 | | | 27 | 20 |
| 1980 | 40 | 30 | 80 | 60 | 120 | 90 |
| 2000 | 40 | 30 | 100 | 80 | 140 | 100 |
| 2020 | 40 | 30 | 180 | 130 | 220 | 160 |

(all figures rounded)

Presently irrigated lands have an adequate water supply to meet their average needs for their present level of development. However, future requirements are based on dry year requirements with more intensive irrigation use. As a result, water use is expected to increase about 50 percent on presently irrigated lands.

New lands expected to be irrigated by 2020 will require farm deliveries of 180,000 acre-feet and their resulting depletions will amount to 130,000 acre-feet. The increased water use is shown by time periods in table 123.

Water requirements in this subregion are essentially the same as in the South Puget Sound area to the north. Both areas are influenced by the cloudy marine weather that reduces temperatures and increases precipitation from that to the east and south. For the periods from the present to 2000 and from 2000 to 2020, estimated farm deliveries are 2.0 and 2.5 acre-feet per acre, respectively, and resulting depletions are 1.5 and 1.8 acre-feet per acre, respectively.

## THE POTENTIAL TO MEET THE NEEDS

More than a half million acres are suitable for irrigation. This is more than 6 times the acreage necessary to meet the 2020 needs as presented in the preceding section. The subregion has an

abundance of good quality water available for irrigation use. With the abundance of water and land, the subregion could provide more of the region's food and fiber requirement than it was assigned.

## Potentially Irrigable Lands

Land classification surveys have identified only about 18 percent of the total land area as suitable for irrigation. Of this amount, little more than 3 percent or 18,000 acres is irrigated, with almost 97 percent, or 558,700 acres, remaining as potentially irrigable. About 95 percent of this potential is located in Washington with the remainder in Oregon. Table 124 shows the average of potentially irrigable lands by land classes.

Table 124 - Potentially Irrigable Lands, Subregion 8

| Area | Class 1 | Class 2 | Class 3 | Total |
|---|---|---|---|---|
| | | (acres) | | |
| Washington | 68,220 | 128,350 | 331,110 | 527,680 |
| Oregon | 230 | 10,470 | 20,340 | 31,040 |
| Total | 68,450 | 138,820 | 351,450 | 558,720 |
| Rounded | | | | 558,700 |

The potentially irrigable lands are scattered throughout the subregion in land blocks of a few acres to more than 5,000 acres in size. Figure 41 shows the location of potentially irrigable lands.

The Washington portion of the subregion contains the majority, almost 528,000 acres, of the potentially irrigable lands. The west slope of the Cascade Range consists mostly of shallow acid soils in mountainous terrain having a forest cover. Lands situated in the valleys adjacent to the Columbia River are suited to irrigation.

The greatest percentage of the potentially irrigable lands are located in the western portion of Clark County, central Cowlitz County, and in south-central Lewis County. Soils in these areas are situated on terraces and terrace plains. These soils are derived for the most part from consolidated old alluvium and residual upland parent materials. The presently cultivated lands were cleared from forests.

The western part of the Washington area, which includes most of Wahkiakum County, consists of residual soils in the valley and foothill areas with alluvial soils on the valley floors.

The Oregon portion of the subregion is located entirely within Columbia County and irrigable lands occur on a wide variety of soils located in the lowland areas. About 31,000 acres in the Oregon portion are potentially irrigable. Of this amount, about two-thirds have been judged as class 3 because of heavy soil textures and/or steep slopes. Only a small acreage, 230 acres, has class 1 potential. A brief summary of the characteristics of each land class follows.

### Class 1

The 68,000 acres of class 1 lands represent about 12 percent of the potentially irrigable area. They are highly productive and capable of producing the highest income crops climatically adapted to the area. Practically all of the class 1 lands are located in the better climated areas of recent and older alluvial soils.

### Class 2

Representing about 25 percent of the potentially irrigable acreage, class 2 lands are suitable for producing most climatically adapted crops, but they will produce lower yields than class 1 lands or require greater costs to produce equal yields.

Most of the class 2 lands are affected by fine textures on a compacted zone which somewhat restricts internal drainage. Other class 2 lands have gravel and cobble in the profile which affects tillage operations or water holding capacity.

### Class 3

Class 3 lands total 351,000 acres, nearly two-thirds of the subregion's potentially irrigable acreage. These lands are of only fair quality, and under irrigation they will be best suited for producing pasture and forage crops.

Like class 2 lands, most of the class 3 lands are affected by compacted or fine textured soils but are more severely restricted by poor internal drainage. Some lands are located adjacent to rivers which must be diked to protect against flooding.

## Water Supply

Average annual discharge of streams originating in the subregion totals 18 million acre-feet. Inflow from other subregions amounts to 152 million acre-feet annually.

An estimated 8 million acre-feet of ground water is stored in a 50-foot thick interval below the water table. The total annual recharge and discharge amounts to about 6 million acre-feet.

## Potential Developments

To meet the 2020 need assigned to this subregion, an additional 82,000 acres must be brought under irrigation. All of the presently irrigated 18,000 acres are adequately irrigated and enough land and water are available to meet the projected need. A significant factor which will affect the development in this subregion is the rapidly expanding urban population. Irrigation may evolve into meeting the special needs of a predominantly urban market.

Nearly all of the 2020 need is expected to come from the Washington portion of the subregion, primarily in two general areas. One area is located generally between Vancouver, Woodland, and Battleground. About 45,000 acres could be served by water diverted from the Lewis River. Ample water is available but storage will probably be required. The area contains a large portion of the class 1 lands within the subregion. The other probable area of irrigation development will be found along the Cowlitz River where lands can easily be served by low pump lifts or gravity diversion from the river or its tributaries. Some 31,000 acres could be irrigated. Storage, especially on the tributaries of the Cowlitz River, may be required to maintain adequate stream levels essential to direct diversions. Class 2 and 3 lands are prevalent in this portion of the subregion.

Low-lying lands along the Columbia River near the communities of Rainier, Clatskanie, and Deer Island in Oregon constitute an area of about 6,000 acres which could be developed for irrigation. The source of water would be low-lift pumping from the Columbia River or wells. Lands in this portion of the subregion are largely classes 2 and 3.

Limited available information indicates that in certain areas of the subregion there would be sufficient ground water for limited irrigation use.

Although the needed irrigation development is expected to be brought about by the initiative of individuals, studies by Federal entities here indicate that about 100,000 acres are suited for project development. These lands could be served by either large multiple purpose or small watershed projects.


LOCATION MAP

# SUBREGION 9

# WILLAMETTE

## THE SETTING

The Wilamette Subregion covers about 12,000 square miles and includes one-eighth of Oregon's area. It is bounded on the north by the Columbia River, on the east by the Cascade Range, on the south by the Calapooya Mountains, and on the west by the Coast Range. The valley of the Willamette River contains about 3,500 square miles of nearly level to gently sloping lands occasionally broken by ridges, buttes, and rolling hills.

The Willamette River and its tributaries collect most of the subregion's runoff and join the Columbia River at Portland. The Sandy River watershed drains the extreme northeast corner of the subregion.

The climate is characterized by dry, moderately warm summers, and wet, mild winters. The growing season exceeds 200 days at lower elevations; in the higher valleys and foothills it is reduced to 150 days. Average temperature and precipitation for the basin's three major cities follow:

| | Annual Precipitation (inches) | Temperature (° F.) | |
|---|---|---|---|
| | | July | January |
| Portland | 42 | 69 | 40 |
| Salem | 42 | 66 | 38 |
| Eugene | 40 | 67 | 39 |

Only about 6 percent of the precipitation falls during the summer. The wet, temperate fall-through-spring climatic regime is conducive to winter growth of such crops as grain, grass, and legume seed, which mature uniformly and produce high quality seed during the dry summer period.

The Willamette Valley was one of the first areas in Oregon to be settled. The Willamette River and its tributaries offered ready-made transportation and domestic water systems. The long growing season encouraged the production of a variety of crops, and the level to gently rolling terrain was easy to cultivate. Abundant trees were

at hand for building and fencing. The highly seasonal distribution of the rainfall seemed to present the only limit to the diversity of crops which could otherwise be produced.

The dry-summer climatic regimen in the subregion has had a profound effect on its agricultural history. Under dryland conditions, farmers either raised early-maturing or drought-resisting crops, or obtained somewhat limited yields of other crops.

The climatic characteristics in combination with an abundant supply of high quality water have been the major factors in the rapid development of a food-processing industry in the Willamette Subregion. The subregion is ranked as one of the largest fruit and vegetable processing areas in the Nation. The winters are mild and perennial crops such as strawberries and cane fruit will not winter-kill. Summer temperatures are conducive to the growth of a wide variety of crops, both dry-farmed and irrigated. Snap beans, sweet corn, strawberries, cane berries, carrots, beets, and kale are the major crops grown for the processing industry. Some of these irrigated specialty crops are grown for their high value seed.

Some 1.3 million, about 65 percent, of Oregon's people lived in the Willamette Subregion in 1965. Population has been growing in the three major cities of the subregion - Portland, Salem, and Eugene - at an annual rate of about 2 percent over the past 25 years. As these urban areas expand, they offer improved markets and better agricultural commodity processing opportunities.

In those parts of the subregion where irrigation has been practiced, significant changes have taken place. Farmers have greater freedom of choice as to what crops can be grown. On some lands, there has been a switch to high-value row crops supporting local cannery and processing industries. On other lands, yields of crops previously dry-farmed have been greatly increased.

The earliest known instance of commercial irrigation dates back to 1890. In the 1890's and early 1900's, a few acres of truck vegetables for the fresh market were irrigated. Most of this early irrigation took place near the cities of Portland, Salem, and Eugene.

Irrigation development proceeded rather slowly through the first four decades of the century. About 1,000 acres were irrigated by 1911, 3,000 acres by 1920, 5,000 acres by 1930, and 27,000 acres by 1940. Most of the growth in the 1930's came in the recovery period after the depression; it was the first period of significant increase. During World War II, acreage under irrigation remained almost static, due largely to shortages of metal for sprinkler pipe systems, which have been used almost exclusively on newly irrigated lands since the 1930's.

Since World War II, the growth of irrigation has been spectacular. This rapid growth in irrigation came primarily as a response to: (a) the concerted campaign of the 1930's to demonstrate the value of irrigation, (b) the war-induced expansion of the aluminum industry which could now provide cheap, abundant, and easily handled pipe for portable sprinkler systems, (c) growth of markets for the output of the basin, (d) development of food processing technology, (e) a need for greater output per acre, and (f) availability of inexpensive power for pumping.

The subregion has been divided into three subareas to simplify presentation of data. Figure 44 shows the relative location of the three subareas. Each subarea contains a major city: Upper, Eugene; Middle, Salem; and Lower, Portland.

The Economic Subregion consists of Benton, Clackamas, Lane, Linn, Marion, Multnomah, Polk, Washington, and Yamhill Counties.

## PRESENT STATUS

An area of about 244,000 acres was irrigated in 1965. An irrigability study of this subregion was made between 1964 and 1966 in connection with the Willamette Basin Comprehensive Study. The general location of irrigated land as well as the potentially irrigable acres is shown on figure 45.

Acreage irrigated, by source of water and adequacy of supply, is shown in table 125. Water supplies are generally adequate except along some of the tributary streams.

Table 125 - Irrigated Area, 1965, Subregion 9

| | Source of Supply | | Water Supply | | |
|---|---|---|---|---|---|
| | Surface | Ground | Adeq. | Inadeq. | Total |
| | (acres) | | | | |
| Subregion 9 | 142,260 | 101,400 | 217,930 | 25,730 | 243,660 |
| Rounded | | | | | 244,000 |

Source: Data gathered by Willamette Basin Task Force.

### Characteristics of Irrigated Areas

Most of the irrigated land in Subregion 9 is located along the entire length of the Willamette River from Eugene downstream and along the lower reaches of the tributary streams. The largest

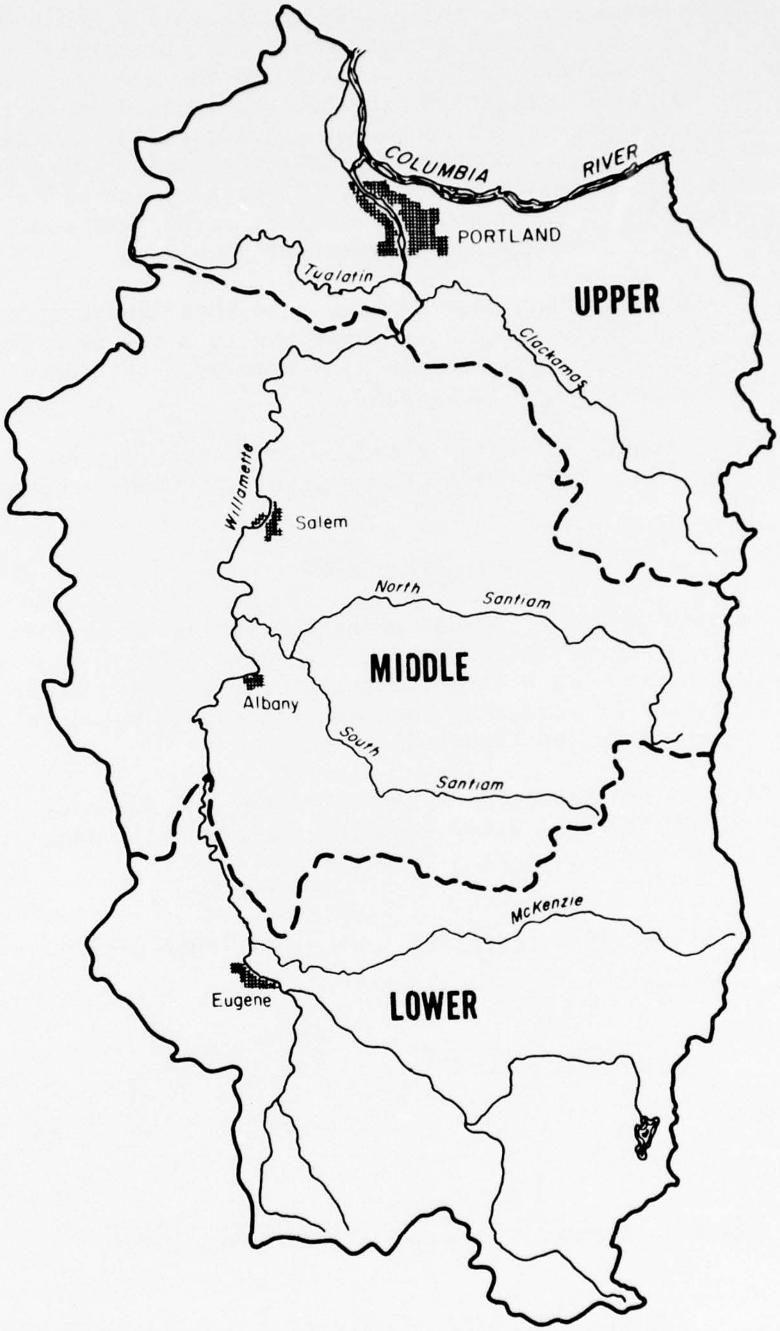
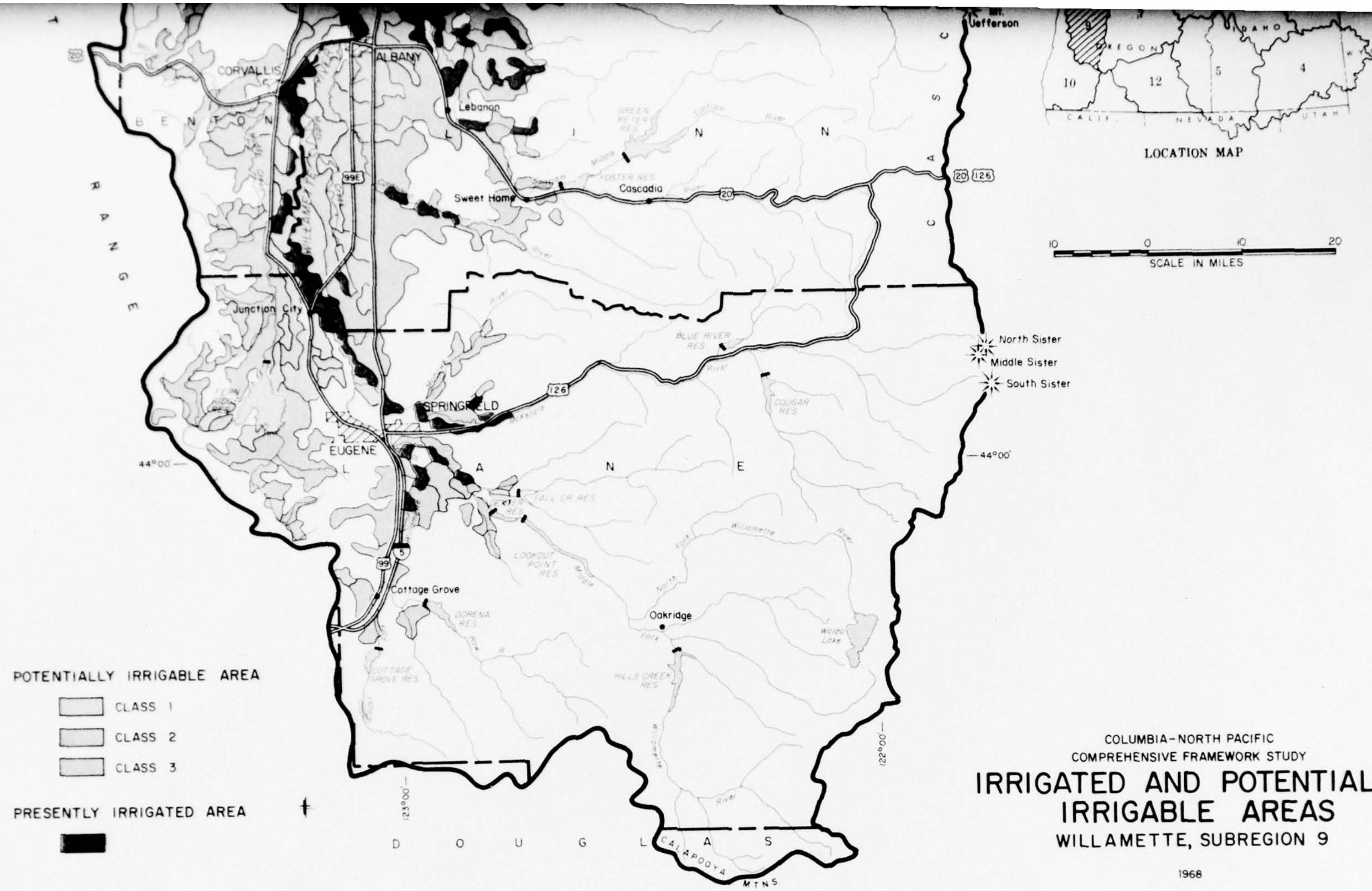



FIGURE 44. Subareas in Subregion 9, Willamette


WASHINGTON
OREGON
COLUMBIA
WASHINGTON
MULTNOMAH
YAMHILL
CLACKAMAS
POLK
MARION
BENTON
LINN
CASCADE RANGE
COAST RANGE
St Helens
Forest Grove
Hillsboro
PORTLAND
Oregon City
Mc Minnville
Molalla
Willamina
Silverton
SALEM
Dallas
Stayton
CORVALLIS
ALBANY
Lebanon
Sweet Home
Cascadia
Junction City
Mt. Hood
Government Camp
Mt. Jefferson
North Sister
BONNEVILLE DAM
COLUMBIA RIVER
BULL RUN RES.
Timothy Lake
Oak Grove Fork
BIG CLIFF RES.
DETROIT RES.
GREEN PETER RES.
FOSTER RES.
BLUE RIVER RES.
−123°00′
−122°00′
45°00′
LOCATION MAP
CANADA
WASHINGTON
MONTANA
OREGON
IDAHO
CALIF.
NEVADA
UTAH
SCALE IN MILES
10 0 10 20




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# IRRIGATED AND POTENTIALLY IRRIGABLE AREAS

WILLAMETTE, SUBREGION 9

1968

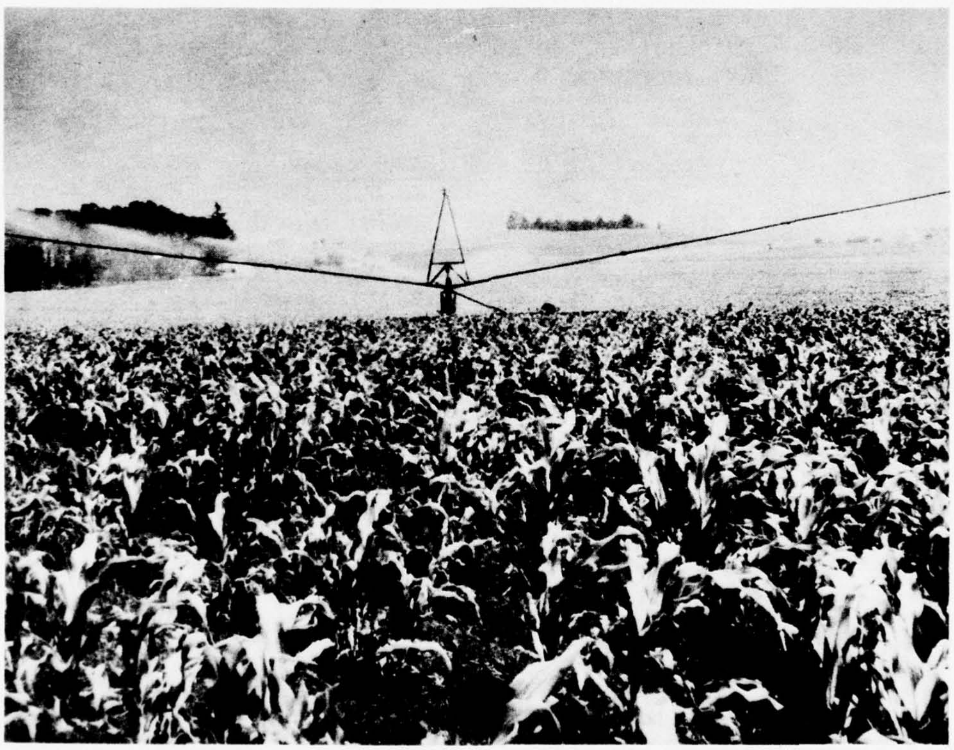
FIGURE 45

2

concentrations are located between Salem and Albany and Salem and McMinnville. Figure 45 shows the location of the presently irrigated lands.

Irrigation plays a major role in the agricultural economy. Although occupying less than one-tenth of the total farmland, irrigated farms produce more than one-third of the total value of all agricultural production. Oregon leads the Nation in production of snap beans and processed strawberries. Nearly all of this production comes from irrigated land. Production of these crops and a variety of other fruits, vegetables, and nuts has made Marion County, located in the center of the subregion, the leading food processing center of the country.

There were approximately 2.4 million acres included in farms or about 29 percent of the total land area according to the 1964 Census of Agriculture. Within this area there were 4,860 irrigated farms, comprising about 836,000 acres. The average irrigated farm size was 172 acres with an average of 39 acres per farm under irrigation.



*Portable boom-type sprinkler system irrigating Willamette Basin corn. (U.S.D.A. Soil Conservation Service)*

The land irrigated slightly exceeded 188,000 acres, or approximately 23 percent of the land in irrigated farms. Irrigated land was about equally divided between forage crops and a wide variety of specialty crops in the subregion. A small percentage of the total was reportedly used for small grains and corn and slightly over 16,000 irrigated acres were not enumerated for any particular crop. Figure 46 shows the proportional amounts of irrigated cropland harvested and irrigated pasture for Subregion 9 in 1964.

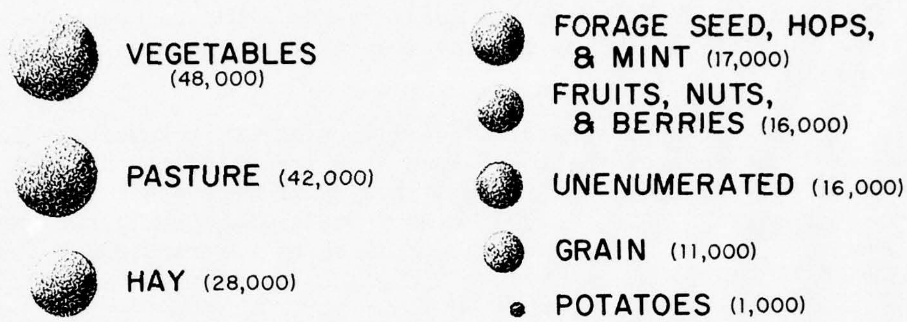



FIGURE 46. Acreage of Irrigated Cropland Harvested and Pasture, 1964, Subregion 9.

## Production of Irrigated Crops

A summary of crop production showing the amount of total output that is produced under irrigation is presented in table 126. Yields of selected major irrigated crops follow in table 127. Irrigation is especially important for the vegetable and fruit crops. It not only provides insurance against drought but proper timing and application can add significantly to both the quantity and quality of production.

Livestock production is also enhanced through irrigation of feed crops. It has been estimated that in 1964 about 14 percent of the livestock feed requirement for the subregion was produced on irrigated land.

## Value of Production

The gross value of crop and livestock production associated with irrigation was estimated at about $61 million in 1964. Vegetable production made the largest contribution to the total with an estimated value of over $18 million. The second largest contributor was horticultural specialties such as flowers, bulbs, nursery stock,

Table 126 - Summary of Crop Production, 1964, Subregion 9

| Crop Category | Units | Production Total (1000's) | Production Irrigated (1000's) | Percent Irrigated |
|---|---|---|---|---|
| Small grains | tons | 289 | 17 | 5.9 |
| All hay | tons | 383 | 74 | 19.3 |
| Dry beans and peas | cwt. | 3 | - | 0.0 |
| Potatoes | cwt. | 581 | 198 | 34.1 |
| Vegetables | cwt. | 7,384 | 6,327 | 85.7 |
| Fruits, nuts, and berries | tons | 106 | 41 | 38.7 |
| Forage seed, hops, and mint | lbs. | 238,654 | 6,928 | 2.9 |

Source: Derived from Census of Agriculture and Agricultural Statistics.

Table 127 - Yields of Selected Major Irrigated Crops, 1964, Subregion 9

| Crop | Units | Yield per Irrigated Acre |
|---|---|---|
| Field crops | | |
| Field corn | tons | 2.18 |
| Hay, alfalfa | tons | 3.9 |
| Other | tons | 2.0 |
| Silage | tons | 11.2 |
| Vegetables | | |
| Sweet corn | cwt. | 112 |
| Snap beans | cwt. | 110 |
| Berries | | |
| Strawberries | tons | 3.8 |
| Caneberries | tons | 2.0 |

and vegetable seed with a total value of more than $13 million. Livestock and livestock products associated with irrigated feed crops amounted to nearly $9 million.

## Economic and Social Impacts

The total value of irrigated agricultural production was $61 million (1964). This is direct value. The indirect or additional

value resulting from allied industry supplying goods and services to irrigated agriculture was estimated to be 2.54 times the direct value. For each dollar of irrigated agricultural revenue an additional $2.54 accrues to the allied industries in the subregion. This amounts to about $156 million. The direct value of $61 million combined with this indirect value of $156 million gives a total gross economic product of $217 million generated as an impact of irrigated agriculture in 1964.

The multiplier of 2.54 is representative of irrigated agriculture in Eastern Washington. In that area, nonirrigated agriculture is not very intensive when compared to the Willamette basin; therefore the impact of irrigation is more dramatically felt. The Willamette basin has a well established very productive nonirrigated agriculture along with associated processing and supply activities. Therefore, the economic impact or changes that take place resulting from irrigation probably are not as dramatic as this multiplier indicates for this subregion.

An estimate of the impact irrigation has had on employment was made. Employment in irrigated agriculture represented about 2 percent of the work force of the area. This consisted of about 8,600 basic agricultural workers. In addition, over 15,000 workers were estimated to be employed in allied industries and services, including processing, transportation, and service activities.

## Use of Water

Only a small portion of the total available water supply is used for irrigation. Use of existing Federal reservoir storage for irrigation is mostly by individuals. There are no large project-type developments in the subregion. Most ground water development has occurred on the east side of Willamette River--immediately north of Salem in the 210 square-mile French Prairie area, and along the Willamette River flood plain. Surface-water development has taken place along the Willamette River and all tributary streams where individual development is economically possible. Summaries of present irrigation from surface and ground water sources are shown in tables 128 and 129.

Irrigation water use varies considerably from year to year, depending on the spring and summer rainfall. Few records of diversion or pumping are available because nearly all irrigation development has been accomplished by individual farmers. Diversion quantities, shown in tables 128 and 129, are based on estimates of consumptive use, irrigation water requirements and losses between the source of supply and the land. System losses are small where water is pumped from the source directly to the farm sprinklers.

Table 128 - Irrigation from Surface Water Sources, 1965, Subregion 9

| Subarea 1/ | Water Rights (acres) | Adequate Supply | | Inadequate Supply 2/ | | | Return Flow (ac-ft) | Depletions (ac-ft) |
|---|---|---|---|---|---|---|---|---|
| | | Area (acres) | Diversion (ac-ft) | Area (acres) | Diversion (ac-ft) | Short (ac-ft) | | |
| Upper Willamette | 139,938 | 15,360 | 37,700 | 1,080 | 2,100 | 600 | 13,900 | 25,900 |
| Middle Willamette | 174,722 | 86,060 | 203,000 | 8,390 | 14,800 | 4,400 | 76,400 | 141,400 |
| Lower Willamette | 60,111 | 15,110 | 39,900 | 16,260 | 32,500 | 10,000 | 24,700 | 47,700 |
| Subregion total | 374,771 | 116,530 | 280,600 | 25,730 | 49,400 | 15,000 | 115,000 | 215,000 |

1/ See subarea divisions on figure 44. The basin was subdivided to facilitate comparison of development.

2/ Irrigation water supply considered inadequate if accumulated annual shortages exceed 100 percent in 10 consecutive years.

Table 129 - Irrigation from Ground Water Sources, 1965, Subregion 9

| Subarea 1/ | Registrations and Permits (acres) | Irrigated Lands (acres) | Pumpage (ac-ft) | Return to Ground Water (ac-ft) | Depletion (ac-ft) |
|---|---|---|---|---|---|
| Upper Willamette | 22,089 | 17,670 | 42,800 | 14,600 | 28,200 |
| Middle Willamette | 103,066 | 77,080 | 178,600 | 61,400 | 117,200 |
| Lower Willamette | 13,313 | 6,650 | 17,600 | 6,000 | 11,600 |
| Subregion total | 138,468 | 101,400 | 239,000 | 82,000 | 157,000 |

1/ See subarea divisions on figure 44. The basin was subdivided to facilitate comparison of development.

An estimated 569,000 acre-feet of water is diverted or pumped for irrigation use.

Total farm losses, distribution system losses, and waste amount to an estimated 254,000 acre-feet annually. Of this amount, about 22 percent is estimated to be consumed nonbeneficially, so water actually returning to the stream channels or recharging ground water supplies amounts to about 197,000 acre-feet. Thus, irrigators annually deplete about 372,000 acre-feet of water from subregion streams and ground water aquifers.

### *Adequacy of Supply*

Water supplies are generally adequate for lands located along the Willamette River and most of its major tributaries. These lands are irrigated from both surface and ground sources. Most of the water-short lands are located west of the Willamette River along the smaller tributaries where low summer flows and overappropriation combine to create late season shortages. Some 26,000 acres have shortages totaling 15,000 acre-feet annually. Virtually all of these lands are irrigated from surface sources. If all lands with surface-water rights were irrigated, considerably more lands would be inadequately supplied, because only about 38 percent of the lands with rights are irrigated in any one year.

Ground water supplies are generally adequate for all lands using this source. Winter precipitation is sufficient to recharge present withdrawals and no large areas of overuse have shown up under present development. Only about 73 percent of the irrigation ground water rights are now used.

### Application of Water

Gravity irrigation was used almost exclusively until 1931 on the small acreage that received irrigation.

Lands are irrigated almost exclusively by sprinkler with most irrigators pumping from streams or ground water into their systems. These systems, which reduce or eliminate the need for leveling and ditching, are preferred because much of the subregion has a rolling surface. Another advantage of using portable sprinkler systems is their flexibility. A rather small amount of pipe can be moved about to water the farm. Oregon State University has played a major role in the early start and development of sprinkler irrigation in the Willamette Subregion.

Hand-move systems are the predominant means of sprinkler irrigation, being used almost exclusively on forage crops, mint,

grass seed, and other field crops. Overhead solid set systems are used to irrigate most pole beans and cane berries. Portable boom systems are important in the irrigation of sweet corn, particularly in the Stayton-Salem area.

### Quality of Water

The history of irrigation has indicated few water quality problems, and there seems to be no deterrent to continued irrigation growth from a water quality standpoint.

In general, both surface and ground waters are of excellent quality for irrigation. As streamflows diminish, surface water carries a larger proportion of total dissolved solids, but no unsatisfactory conditions have resulted. Ground water supplies contain more dissolved solids, but their quality for irrigation is usually excellent. Water found in older marine sedimentary formations appears to be doubtful in quality, but it has been encountered only in isolated areas.

The impact of irrigation on the quality of the subregion's water supply appears to be minimal. The most obvious potential for stream pollution by irrigation is from return flow, but few data are available on its effect. Analyses of samples indicate much of the natural and applied minerals and chemicals are removed during the fall and winter. As streamflows are generally high in those seasons, the chemicals do not appreciably affect water quality.

## FUTURE NEEDS

Projections are that by 2020 the irrigated acreage will increase to 1,000,000 acres, more than four times the 244,000 acres presently irrigated. By 1980, 430,000 acres will be irrigated; by 2000, the irrigated total should be 850,000 acres. These projections were developed for the Willamette Basin Comprehensive Study. The development of these projections, in addition to water requirements and anticipated production, are presented in this section.

The estimated increase of irrigation takes into account regional needs for food and fiber adjusted to reflect historical trends, availability of land and water, authorized Federal developments, anticipated state, Federal and private developments and other economic factors which affect irrigation expansion.

### Lands

Irrigated acreage projections were based primarily on the satisfaction of future food and fiber requirements with some

consideration given to available land and water. Table 130 summarizes the projected irrigated area needs. All irrigated lands are included whether or not they were used for crop and pasture production. These acreages were developed from harvested irrigated cropland and pasture needs adjusted to include other irrigated lands.

Table 130 - Irrigated Area Needs by 1980, 2000, and 2020, Subregion 9

| Item | Irrigated Acreage | | |
|---|---|---|---|
| | 1980 | 2000 (1000's) | 2020 |
| Harvested cropland and pasture 1/ | 366 | 722 | 850 |
| Other 2/ | 64 | 128 | 150 |
| Total irrigated area | 430 | 850 | 1,000 |

1/ From table 131.
2/ Includes irrigated forest, range, rights-of-way, ditches, roadways, farmsteads, urban, and idle irrigated lands not used in the production of projected crop requirements.

*Without irrigation, it is likely that the land in the foreground which now supports high value bush beans would also be planted in hay. (U.S.D.A. Soil Conservation Service)*

Irrigated cropland harvested and pasture needed to meet future food and fiber requirements are summarized by crop category in table 131. Small grains, feed crops, forage seed, hops, and mint are projected to become major users of irrigated land. This is reasonable for feed crops; however, one might question these results for small grains and forage seeds. The small grains and some of the major grass seeds such as rye grass are early maturing and can therefore obtain adequate moisture in most years from spring rains. Vegetables and fruits are expected to continue as important irrigated crops.

Table 131 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020, Subregion 9

| Crop Category | Acreage Needs 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|
| Small grains | 90 | 135 | 143 |
| All hay | 32 | 105 | 136 |
| Potatoes | 2 | 4 | 4 |
| Vegetables | 50 | 60 | 54 |
| Fruits, nuts, and berries | 19 | 29 | 26 |
| Forage seed, hops, and mint | 83 | 149 | 184 |
| Pasture | 48 | 159 | 207 |
| Unenumerated | 42 | 81 | 96 |
| Total | 366 | 722 | 850 |

Note: These figures are adapted from the Willamette Basin Comprehensive Study

## Production and Yield

A summary of projected crop production from irrigated land is presented in table 132.

Crop yields in the form of indexes are shown for 1980, 2000 and 2020 in figure 47. The indexes are based on 1964 yields equaling 100. A further discussion of yields is presented in the regional summary.

## Value of Production

Values of projected irrigated crop production were estimated using the price structure established by the Office of Business Economics and the Economic Research Service (OBERS) in the regional food and fiber projections. Livestock feed crops with the exception

of pasture are included in these projected values. Table 133 presents these values of the three study years.

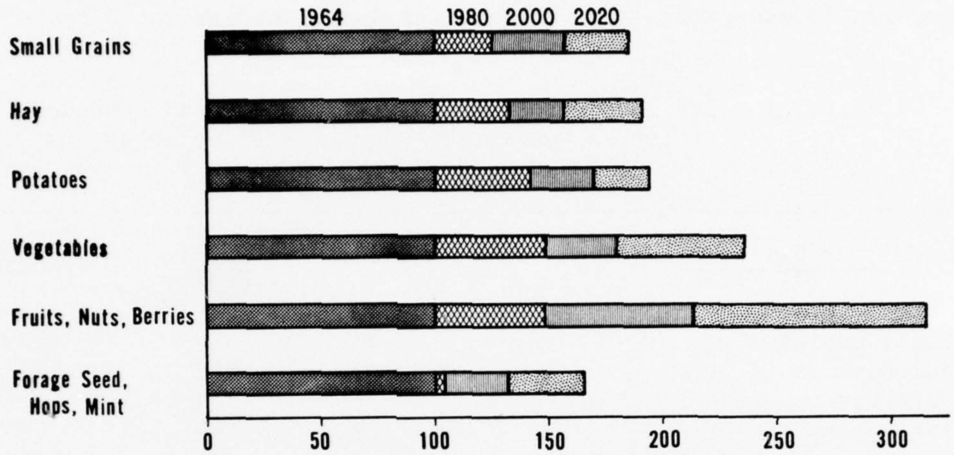



FIGURE 47. Yields for Selected Crops for 1980, 2000, and 2020 (1964 as Base Year Equals 100), Subregion 9.

Table 132 - Crop Production from Projected Irrigated Acreage for 1980, 2000, and 2020, Subregion 9

| Crop Category | Units | Production 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|---|
| Small grain | tons | 184 | 349 | 434 |
| Hay | tons | 114 | 439 | 693 |
| Potatoes | cwt. | 518 | 1,248 | 1,411 |
| Vegetables | cwt. | 9,690 | 14,070 | 16,605 |
| Fruits, nuts, and berries | tons | 73 | 160 | 215 |
| Forage seed, hops, and mint | lbs. | 78,799 | 179,615 | 280,170 |

Table 133 - Value of Projected Irrigated Crop Production, Subregion 9

| Crop Category | Value of Production 1/ 1980 | 2000 ($1,000) | 2020 |
|---|---|---|---|
| Small grains | 9,700 | 18,000 | 23,000 |
| Hay | 2,500 | 9,400 | 14,900 |
| Dry beans and peas | - | - | - |
| Sugar beets | - | - | - |
| Potatoes | 700 | 1,700 | 1,900 |
| Vegetables | 28,800 | 41,800 | 49,300 |
| Fruits, nuts, and berries | 8,800 | 19,300 | 26,000 |
| Forage seed, hops, and mint | 16,400 | 37,300 | 58,300 |
| Total | 66,900 | 127,500 | 173,400 |

1/ Based on projected normalized prices.

## Water

Additional depletions resulting from meeting supplemental irrigation needs and irrigation of previously dry land are expected to total approximately 1,638,000 acre-feet by 2020. This figure combined with 1965 depletions of 372,000 acre-feet indicates that by year 2020 some 2,010,000 acre-feet will be depleted from Subregion 9 water supplies as a result of irrigation. Depletions and farm deliveries are summarized by time periods in table 134.

Table 134 - Projected Farm Deliveries and Depletions, Subregion 9

| Year | Presently Irrigated Farm Delivery | Presently Irrigated Depletion | Future Irrigation Farm Delivery (1,000 ac-ft) | Future Irrigation Depletion | Total Farm Delivery | Total Depletion |
|---|---|---|---|---|---|---|
| 1965 | 537 | 372 | | | 537 | 372 |
| 1980 | 550 | 380 | 520 | 390 | 1,070 | 770 |
| 2000 | 550 | 380 | 1,700 | 1,270 | 2,250 | 1,650 |
| 2020 | 550 | 380 | 2,180 | 1,630 | 2,730 | 2,010 |

Supplemental

To supply the inadequately irrigated lands an additional annual diversion supply of 15,000 acre-feet needs to be developed. This will provide an additional farm delivery of 14,400 acre-feet and result in an additional depletion of 10,200 acre-feet. The annual need is shown in table 135.

Table 135 - Supplemental Irrigation Diversion Requirements
Subregion 9

| Subarea | Water-short Lands (acres) | Supplemental Requirement (acre-feet) |
|---|---|---|
| Upper | 1,080 | 600 |
| Middle | 8,390 | 4,400 |
| Lower | 16,260 | 10,000 |
| Total | 25,730 | 15,000 |

Full

The Willamette Valley is located between the relatively low Coast Range and the higher Cascade Range. Consequently, its climate is somewhat of an average of areas to the east and west. This difference in climate is reflected in the irrigation water requirements

Most of the irrigable area in the Willamette basin is located below 500 feet elevation and therefore has about the same water requirements. A narrow band of foothill area around the valley lands has more precipitation and somewhat lower requirements. However, average requirements in the Upper, Middle, and Lower subareas of the basin are essentially the same. Farm delivery requirements and depletions for new lands to be irrigated before 2000 are estimated to be 2.8 and 2.1 acre-feet per acre, respectively. These values are expected to increase to 3.2 and 2.4 acre-feet per acre for new lands to be irrigated between 2000 and 2020 because more intensive irrigation will be required to produce anticipated higher yields.

New lands to be irrigated by 2020 will need 2.2 million acre-feet of water at the farms. Depletions resulting from this supply will amount to 1.6 million acre-feet as shown in table 134.

## THE POTENTIAL TO MEET THE NEEDS

The Willamette Subregion has a potentially irrigable area of about 1.5 million acres. Another 244,000 acres are presently irrigated. In order to have a projected acreage of 1,000,000 acres by 2020, Federal and private developments will have to be coordinated. Annually there is more than an adequate water supply to meet the projected irrigated acreage. To insure that the irrigation water will be available when needed, additional storage will be required.

### Potentially Irrigable Lands

As part of the Willamette Basin Comprehensive Study, a land classification survey was made to determine the irrigation potential of the subregion. Those lands determined to be potentially irrigable were separated into three classes based on specifications similar to those used for this Columbia-North Pacific study.

The survey identified 1.5 million acres as potentially irrigable. Most of these lands are cleared and in agricultural use; however, about 160,000 acres have a cover of trees, brush or stumps which would have to be removed prior to cultivation and irrigation. Most of these uncleared lands are in private ownership, and some are being cleared each year for agricultural use. However, it is expected that a large portion will be more valuable for tree farms, residential development, or for other nonagricultural uses. About 15,000 acres of land in national wildlife refuges, state game refuges, and state parks are included. Their use would not necessarily be limited to wildlife or recreation because they have soils, drainage, and topographic characteristics suitable for irrigated agriculture.

From the land quality standpoint, the subregion has one of the best potentials for irrigation development in the entire Columbia-North Pacific Region; 56 percent of the lands are in classes 1 and 2. Potentially irrigable lands are located on figure 45 and table 136 presents acreages by land classes for the various study areas. A discussion of each also follows.

Table 136 - Potentially Irrigable Land, 1965, Subregion 9

| Subarea | Class 1 | Class 2 | Class 3 | Total |
|---|---|---|---|---|
| | | (acres) | | |
| Upper | 34,100 | 52,440 | 87,210 | 173,750 |
| Middle | 187,650 | 356,790 | 487,620 | 1,032,060 |
| Lower | 96,690 | 119,210 | 81,080 | 296,980 |
| Total | 318,440 | 528,440 | 655,910 | 1,502,790 |

Class 1

Class 1 lands total about 318,000 acres, 21 percent of the potentially irrigable area. They are highly productive lands, well suited for production of a wide variety of crops such as vegetables, berries, fruits, and nuts.

For the most part, the potentially irrigable class 1 lands have soils formed from old alluvial materials deposited by moving waters, as opposed to some other soils which are formed from the deposits of still water. They are brown colored, friable, medium textured soils, moderately acid in reaction, and usually overlie a slightly coarser textured material. They have an undulating or gently rolling surface topography. Some would be a little difficult to irrigate by gravity methods, but are well suited for sprinkler irrigation. It is a common practice to do a small amount of land leveling even with sprinkler systems to obtain uniform coverage. The class 1 lands have good drainage, both surface and subsurface. However, the natural drainage condition is slightly impeded in some placed by clogged natural drain channels or by roads with shallow culverts.

Class 2

Class 2 lands total about 529,000 acres, 35 percent of the potentially irrigable land. These are good quality lands, suitable for most climatically adapted crops, such as berries, pasture, and hay.

The potentially irrigable class 2 lands have soils which are moderately acid in reaction, and range in color from gray brown to reddish brown. The texture is usually loam to clay loam, and the soil profile often has a thin zone of compaction at a depth of 2 to 4 feet. Most of the class 2 land is quite smooth, with some very gentle rolls, but well suited for sprinkler irrigation. A small percentage has a slope of 8 percent or greater which may require special management practices, even with sprinkler irrigation systems.

About half of the class 2 lands have a minor drainage deficiency. Tile drains are widely used in the Willamette Valley on these lands, both under irrigation and under dryland farming. They are very effective for dry farming because they remove the excess winter water so the land can be tilled shortly after the heavy winter rains are over. However, with or without drainage improvement, these lands have good irrigation potential.

## Class 3

Class 3 lands total about 656,000 acres, or 44 percent of the potentially irrigable lands. These lands are of fair quality but have a rather limited crop range under irrigation, usually hay or pasture. Under dryland conditions, they are used mainly for production of small grains and grass seed.

Most of the potentially irrigable class 3 lands have fine textured surface soil and/or subsoil combined with restricted drainage. These soils were formed from fine textured alluvial materials deposited in rather calm backwaters of flooding streams. These lands have a smooth surface topography with slope generally not over one-half percent. Drainage, both surface and subsurface, is poorly developed because of the flat surface topography, lack of drain outlets, and the dense subsoils. Drainage improvement has been accomplished on a limited scale by channel improvement of a few tributary streams. Irrigation project development will require an extensive drain system to remove excess surface runoff in order to achieve maximum production. With some shallow drainage improvement and with careful management, these lands could be used successfully for various irrigated crops including snap beans, peas, and corn, in addition to hay and pasture.

The other class 3 lands are located off the valley floor on slopes ranging from 8 to 20 percent. Shallow soil depth over rock or fine soil texture, combined with the slope, limit their productivity under irrigation.

## Water Supply

Discharge of subregion streams averages about 28 million acre-feet annually. The Columbia River, which abuts the subregion to the north, passes an additional 130 million acre-feet of water annually.

The quantity of water stored in the uppermost 50 feet of the aquifer units in the subregion is roughly 27 million acre-feet. Ground water discharge is about 11 million acre-feet annually or almost 40 percent of the surface runoff. There are several alluvial aquifers where well yields of between 500 to 1,500 gallons per minute have been attained. The largest such area is the French Prairie area near Salem. The U. S. Geological Survey estimates that ground water reserves in the French Prairie area are capable of yielding 100,000 acre-feet per year.

## Potential Developments

Present development has been based primarily on private initiative and capital. Future development will become increasingly dependent on existing and new storage and on development of distribution systems capable of delivering water to lands located considerable distance from the source of supply.

### Developments by Subarea

Each subarea will continue to increase in irrigated acreage. The more than 1.5 million acres of potentially irrigable land remaining for development is divided into the three subareas as follows: Upper, 173,750; Middle, 1,032,000; and Lower, 297,000 acres. Private individuals and groups and public agencies are studying small and large-scale project-type developments in each of the three subareas in Subregion 9.

### Private Development

It is anticipated that individual farmers will continue to develop their own irrigation resources through the use of surface flows, farm ponds, existing Federal storage reservoirs, and ground water. As lands adjacent to natural streamflows are developed, water users will start forming irrigation cooperatives in order to get water supplies to new land developments.

The major ground water development will be along the Willamette River and its tributaries and other smaller areas in the basin. It is anticipated that about 35 percent of the 2020 irrigation needs will be met through private initiative developing farm ponds and ground water resources.

### Federal Development

Cooperative plans and finances from both individuals and Federal agencies will be required to fully utilize the existing irrigation storage in the presently constructed Federal reservoirs. Supply from this source is adequate to irrigate over 400,000 acres of land. To utilize this water will require large-scale, project-type developments.

Most of the current interest in project-type irrigation developments is in the northern half of the subregion. Presently, local sponsors are backing four Federal projects totaling over 70,000 acres in Polk, Yamhill, and Washington Counties. Interest

in the rest of Subregion 9 is fairly good but areas of concentrated interest are small. It is anticipated that irrigation interest will increase in the southern part of the basin since the recent formation of the Upper Willamette Resource Conservation and Development Project.

Federal legislation has been enacted which encourages the development of smaller scale project-type irrigation developments. The Lower Amazon Flat Project near Junction City which will irrigate about 3,000 acres is an example of small, project-type developments which have been approved for construction. Other studies are underway such as the McKay-Rock Creek Project in the Tualatin subbasin which is designed to irrigate 5,000 to 6,000 acres.

Feasibility studies have been completed on three multiple-purpose projects in the subregion which would irrigate about 60,000 acres. In addition, studies are currently being made for project developments which could bring over 200,000 acres under irrigation.


LOCATION MAP

# SUBREGION 10

# SUBREGION 10

# COASTAL

## THE SETTING

The Coastal Subregion extends from the California border to the end of Washington's Olympic Peninsula, a distance of over 500 miles. Of its nearly 24,000 square-mile area, about one-fourth is located along the Pacific Coast north of the Columbia River; the remainder is in western Oregon.

Physiographically, the subregion has three distinct parts; the coastal strip, the coastal mountain range, and the interior portions of the three major river basins--the Rogue, Umpqua, and Chehalis.

For purposes of discussion, this subregion has been divided into four subareas; the Coastal, the Rogue, the Umpqua, and the Chehalis. Figure 48 shows this location.

The climate of the coastal strip is markedly uniform. Precipitation is high, ranging from 50 inches in the inland areas to 200 inches in some locations along the coast. Summers are quite dry with no more than about 7 inches total precipitation in any agricultural area during the June-July-August period. Growing seasons are long, averaging from 180 to 200 frost-free days and ranging as high as 300 frost-free days at Brookings on the southern Oregon coast. Average temperatures vary only about 15 to 25 degrees summer to winter.

Of the four subareas, the Coastal has the longest history of settlement. Oregon's oldest city, Astoria, was founded in 1811. Aberdeen and Hoquiam in Washington and Coos Bay and Astoria in Oregon are the largest cities of the Coastal subarea. They are in the 10,000-20,000 population class.

The agricultural strip in this subarea is usually no more than a very few miles in width. Agriculture on this strip of land and in the narrow, steep canyons of the Coast Range foothills is livestock oriented. The raising of forage crops for the dairy industry is most important to the subarea's agricultural economy. Various specialty crops including lily bulbs, cut flowers, vegetables, cranberries, and other small fruits are also grown.

There are several blocks of agricultural development such as the Grays Harbor and Willapa Bay areas in Washington and the


FIGURE 48. Subareas in Subregion 10, Coastal.

Tillamook-Nehalem River, and Coquille areas in Oregon. Small concentrations of development have taken place at the mouths of the valleys on virtually all of the main coastal streams. The relatively flat arable lands along the coast are dissected by fingers of the Coast Range foothills which often extend to the ocean. The timber industry, based on spruce, Douglas fir, hemlock, and cedar forests of the Coast Range, forms the main foundation of the economy.

Agriculture in the Coast Range itself is very limited. It is confined mainly to small acreages of hay and pastureland which occupy narrow strips along the coast or on recent flood plains along the streams traversing the range. Irrigation in this subarea has been developed by individual enterprise.

The largest irrigated areas of Subregion 10 are in the Rogue and Umpqua subareas. The Rogue subarea extends generally in a broad crescent from south of Ashland through Grants Pass to Cave Junction. About 75 percent of the Rogue Basin is forested, and the forst products industry is the most important contributor to the basin's economy. Since 1940, the agricultural contribution to the economy has run second only to forestry. The Rogue Basin is one of the major pear-growing regions of the Nation. Apple, peach, and livestock production are also significant.

Irrigation is vital to the agricultural economy in the Rogue Basin. Of the 118,000 acres irrigated, some 50,000 are served from organized districts; the remaining acreage is served from privately constructed facilities. Most irrigation water comes from natural streamflow and storage; ground water development is not significant.

The appealing climate and the proximity of the subarea to populous California are causing a rapid population increase. This is resulting in an increase in land values, and a heightened interest in use of land for purposes other than agriculture.

Medford vies with Corvallis, in the Willamette Subregion, for position as the state's fourth largest city; each had a population estimated at about 30,000 in 1967. Grants Pass has about 13,000 people, and Ashland has over 12,000. The area is linked with the Willamette Subregion and northern California by Interstate Freeway 5 and has rail and good airline service.

The Umpqua subarea lies just north of the Rogue subarea. Here, too, climate is fairly mild. Elevation of the agricultural lands ranges from about 100 to 2,000 feet and the growing seasor averages from 180 to 200 days. Roseburg, with a 1967 population of 15,000, is the subarea's principal population and commercial center; it is linked with points north and south along Interstate 5. There are no existing project-type developments in the subarea.

This subarea, a part of Douglas County, is presently the state's number one timber and sheep producing county. The timber industry holds the dominant economic position in the Umpqua subarea. Beef production and dairy products, cantaloupe, beans, corn, cauliflower, fruit and nuts, and vegetable seed output also contribute to the economy.

The Upper Chehalis River subarea in Lewis County, Washington, lies just south of Puget Sound and east of the Coast Range. Although only about 9,000 acres are presently irrigated, the potential for development is relatively large. The subarea has a large amount of potentially irrigable land which is situated close to the rapidly expanding Puget Sound market area. Irrigated land is devoted primarily to grass, silage, and hay production in support of a livestock and dairy industry.

## PRESENT STATUS

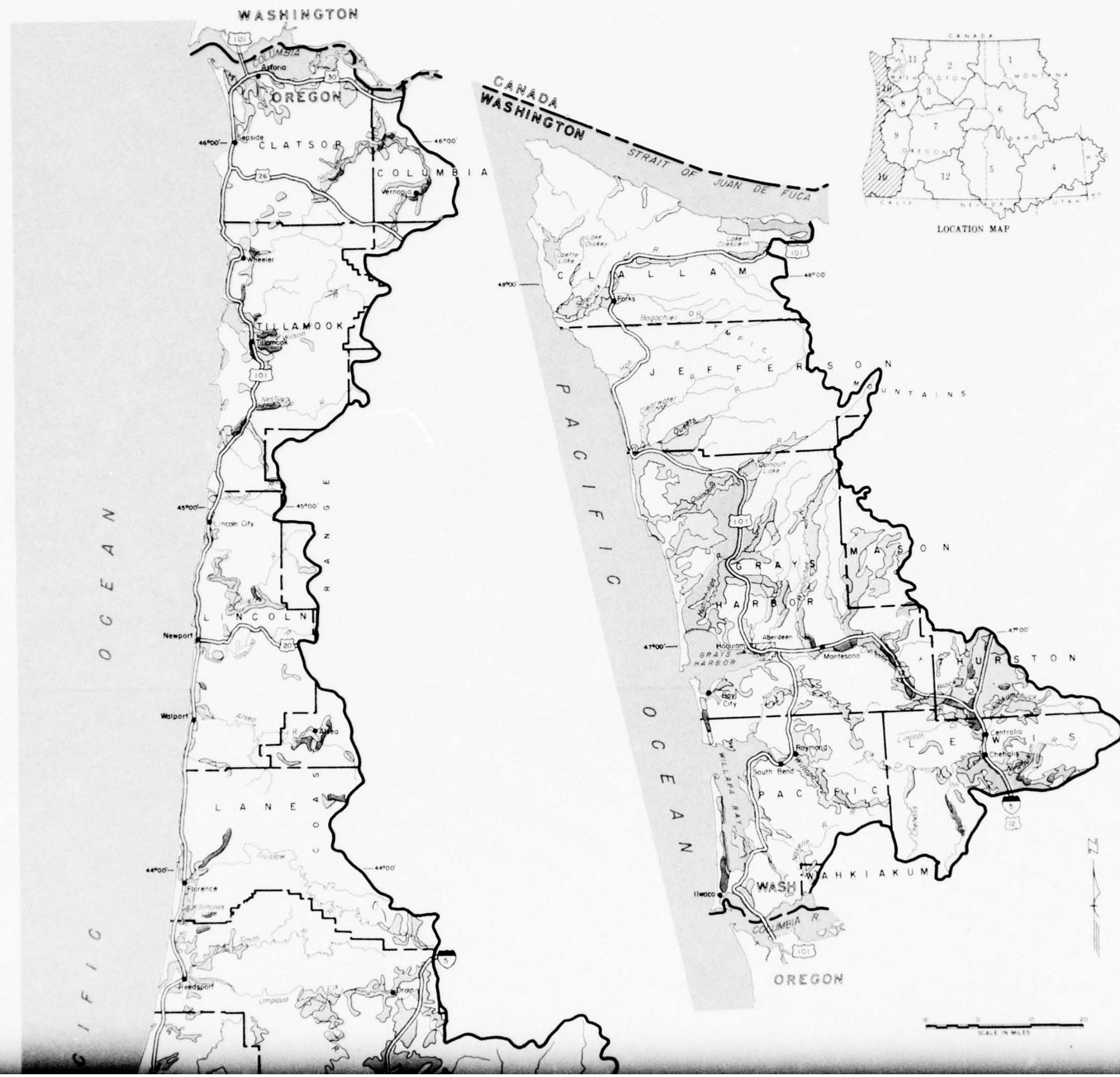
As of 1966, there was an irrigated area of 181,000 acres in the subregion. About 93 percent of this land is located in Oregon. Gravity systems irrigate over 60 percent of the land. The fact that major irrigation development within the subregion has taken place in the Rogue basin area of southwestern Oregon where gravity systems predominate, largely accounts for this circumstance. The area irrigated is shown in table 137 by source of water, method of irrigation, and adequacy of supply. Location of the irrigated area as well as the potentially irrigable areas are shown on figure 49.

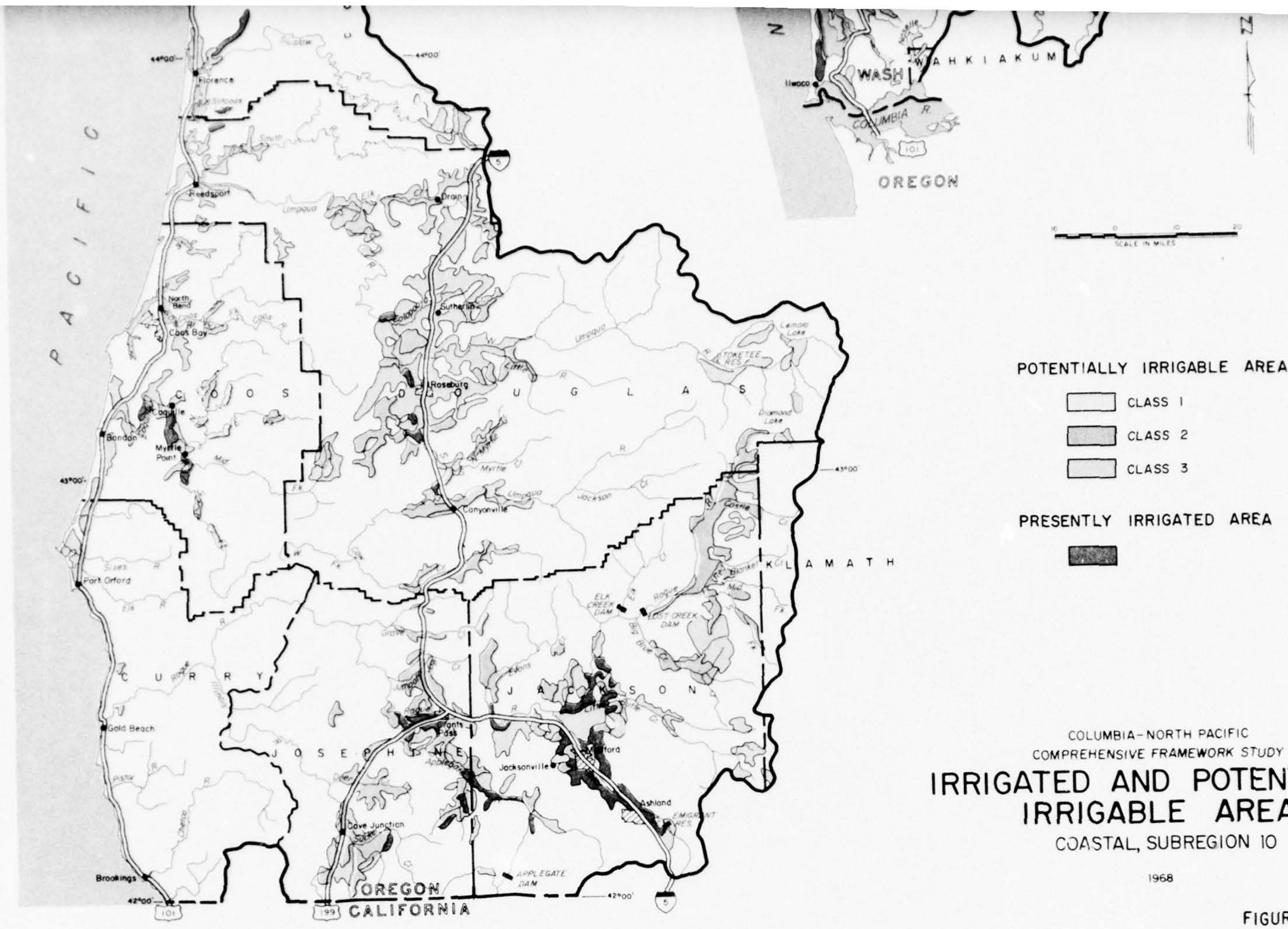
Table 137 - Irrigated Area, 1966, Subregion 10

| State | Source of Supply | | Water Supply | | Method of Irrigation | | Total |
|---|---|---|---|---|---|---|---|
| | Surface | Ground | Adeq. | Inadeq. | Sprinkler | Gravity | |
| | | | | (acres) | | | |
| Oregon | 166,600 | 1,000 | 121,100 | 46,500 | 55,400 | 112,200 | 167,600 |
| Washington | 7,800 | 5,600 | 13,000 | 400 | 13,400 | - | 13,400 |
| Total | 174,400 | 6,600 | 134,100 | 46,900 | 68,800 | 112,200 | 181,000 |

Source: Data gathered by Soil Conservation Service, Bureau of Reclamation, and various state and local agencies.

Included with the presently irrigated area are irrigated lands in urban use, forest nurseries and seed orchards, recreation sites, and other nonagricultural uses.


WASHINGTON
OREGON
CANADA
STRAIT OF JUAN DE FUCA
CLATSOP
COLUMBIA
TILLAMOOK
LINCOLN
LANE
COAST RANGE
CLALLAM
JEFFERSON
OLYMPIC MOUNTAINS
GRAYS HARBOR
MASON
THURSTON
LEWIS
PACIFIC
WAHKIAKUM
WASH
PACIFIC OCEAN
GRAYS HARBOR
WILLAPA BAY
COLUMBIA R.
Astoria
Seaside
Vernonia
Wheeler
Tillamook
Lincoln City
Newport
Waldport
Florence
Reedsport
Drain
Forks
Hoquiam
Aberdeen
Montesano
Centralia
Chehalis
Raymond
South Bend
Ilwaco
Bay City
46°00'
45°00'
44°00'
48°00'
47°00'
101
30
26
20
5
12
LOCATION MAP
SCALE IN MILES




COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# IRRIGATED AND POTENTIALLY IRRIGABLE AREAS

COASTAL, SUBREGION 10

1968

FIGURE 49

## Characteristics of Irrigated Areas

Each of the four subareas has some irrigated land. The heaviest concentrations occur in the Rogue subarea in the vicinity of Medford and Grants Pass.

Irrigation has contributed significantly to fruit production in the subregion. The upper reach of the Rogue River in Jackson County shares the lead in Oregon's pear production with Hood River County in Subregion 7. Nearly 80 percent of this crop is irrigated. The Rogue area also produces other fruits, field and seed crops, and livestock. The Umpqua subarea concentrates on irrigated forage and livestock output, particularly sheep, along with fruit, nuts, and vegetable production. Crops such as alfalfa and small grains which do not produce well along the coast are also grown in the Rogue, Umpqua, and Chehalis subareas.

The part of the subregion which lies to the west of the Coast Range is characterized by scattered production of a variety of crops. The Grays Harbor and Willapa Bay areas in Washington, and the Tillamook-Nehalem River, and Coquille areas of Oregon represent the primary agricultural concentrations along the coast. Livestock products, horticultural and vegetable crops are the main output of these areas. Cranberries--unique to this subregion--vegetables, and such horticultural crops as bulbs, cut flowers, holly and small fruits are produced throughout the coastal subarea. A most distinctive output of the coastal strip is its dairy products for which Tillamook, Oregon, in particular is noted.

There are approximately two million acres in farms comprising about 16 percent of the total land area of the Coastal Subregion. There are about 3,000 irrigated farms which average 250 acres in size. The average amount of irrigated land per farm is 34 acres.

The Washington counties of Grays Harbor and Pacific and the Oregon counties of Clatsop, Coos, Curry, Douglas, Jackson, Josephine, Lincoln, and Tillamook make up the economic study area. Over 80 percent of the 100,500 acres of irrigated land enumerated in the 1964 Census of Agriculture was used to produce hay, silage, and pasture. Fruit, nuts, and berries were produced on about 15 percent of the land enumerated. All other crops combined accounted for the remaining 3.4 percent of the irrigated cropland. About 7,200 acres were reported as irrigated land but were not identified with any particular crop. Figure 50 shows a comparison of irrigated cropland harvested and pasture for various crop categories in Subregion 10.

## Production of Irrigated Crops

Climatic conditions in Subregion 10 are extremely varied ranging from the rain forests of the Olympic Peninsula to the

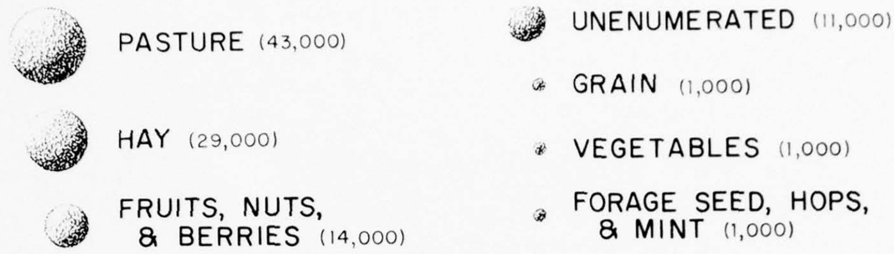



FIGURE 50. Acreage of Irrigated Cropland Harvested and Pasture, 1964, Subregion 10.

*Harvesting cranberries in a large bog in the coastal area of Washington. The machine, a "Beater," shakes the berries from their vines and they are collected when they float to the surface. (Bureau of Reclamation)*

relatively dry Rogue River Valley. Irrigation, of course, has been utilized principally in the more arid areas and is a major factor in the subregion's fruit production. A summary of crop production showing the amount of total production that came from irrigated land in 1964 is presented in table 138. Yields of selected irrigated crops are presented in table 139.

Table 138 - Summary of Crop Production, 1964, Subregion 10

| Crop Category | Units | Production Total (1000's) | Production Irrigated (1000's) | Percent Irrigated |
|---|---|---|---|---|
| Small grains | tons | 8 | 2 | 25.0 |
| All hay | tons | 201 | 68 | 33.8 |
| Dry beans and peas | cwt. | 1 | - | 0 |
| Potatoes | cwt. | 31 | 2 | 6.5 |
| Vegetables | cwt. | 120 | 80 | 66.7 |
| Fruits, nuts, and berries | tons | 82 | 64 | 78.0 |
| Forage seed, hops, and mint | lbs. | 1,606 | 935 | 58.2 |

Source: Derived from Census of Agriculture and Agricultural Statistics.

Table 139 - Yields of Selected Major Irrigated Crops, 1964, Subregion 10

| Crop | Units | Yield per Irrigated Acre |
|---|---|---|
| All vegetables | cwt. | 156 1/ |
| Cranberries | tons | 3.4 |
| Hay | | |
| Alfalfa | tons | 3.0 |
| Clover | tons | 2.1 |
| Grain hay | tons | 2.3 |
| Wild hay | tons | 1.6 |
| Mint oil | lbs. | 63 |
| Hops | lbs. | 1,680 |

1/ Estimated.

## Value of Production

Cash crops grown on irrigated land and irrigated livestock feed crops had an estimated value of nearly $16 million in 1964. Of this total, irrigated crops excluding livestock feed crops were valued at nearly $10 million. Fruits and berries provided over two-thirds of this value. Livestock supported by irrigated feed crops provided the remaining $6 million value.

## Economic and Social Impacts

Income and employment associated with irrigated agriculture are used as indicators of the impact of irrigation. The total value of the output from irrigated land was estimated at $16 million. In addition, there are indirect values resulting from supply of goods and services to irrigated agriculture from allied industries. These service activities and value added from processing contribute another $41 million which gives a total gross value of $57 million generated by irrigated agriculture.

Total employment associated with irrigated agriculture was estimated at 12,000 workers in 1964. Of this total, there were 4,000 basic farm workers and 8,000 additional workers in allied industries.

## Use of Water

There were 174,400 acres irrigated from surface sources in 1966, of which about two-thirds were located in the Rogue River basin. Most of the 6,600 acres developed with ground water supplies are located in Washington. Summaries of present irrigation from subsurface and ground water sources are shown in tables 140 and 141.

The amount of spring and summer rainfall is reflected in the amount of water diverted for irrigation each year. Since most irrigation development has been accomplished by individual farmers, few records of diversion or pumpage are available. Estimated diversion quantities are based on available records and estimates of consumptive use and irrigation water requirements. An estimated 600,000 acre-feet of water are diverted or pumped for irrigation use. This amount includes both the water delivered to the farms, plus the distribution system losses and operational wastes. System losses are small where water is pumped from the source directly to the farm sprinklers. Low farm efficiencies and high distribution system losses result in large diversions in the Rogue basin.

Farm losses, distribution system losses, and waste total an estimated 326,000 acre-feet annually. About 20 percent is consumed nonbeneficially, so water actually returning to stream channels or recharging ground water supplies is about 261,000 acre-feet. This return flow subtracted from the 600,000 acre-feet diversion gives a depletion of about 339,000 acre-feet of water annually from subregion streams and ground water aquifers.

## Adequacy of Supply

Water supplies are generally adequate for lands located along major streams. Most shortages result from a combination of low summer

Table 140 - Irrigation from Surface Water Sources, 1966, Subregion 10

| State | Irrigated Area (acres) | Adequate Supply Area (acres) | Adequate Supply Diversion (ac-ft) | Inadequate Supply Area (acres) | Inadequate Supply Diversion (ac-ft) | Return Flow (ac-ft) | Depletions (ac-ft) |
|---|---|---|---|---|---|---|---|
| Oregon | | | | | | | |
| Rogue River | 117,700 | 79,000 | 331,800 | 38,700 | 130,000 | 211,100 | 250,700 |
| Umpqua River | 17,200 | 12,300 | 41,000 | 4,900 | 12,300 | 22,100 | 31,200 |
| Coastal | 31,700 | 28,900 | 53,400 | 2,800 | 4,200 | 18,200 | 39,400 |
| Subtotal | 166,600 | 120,200 | 426,200 | 46,400 | 146,500 | 251,400 | 321,300 |
| Washington | | | | | | | |
| Chehalis River | 6,000 | 6,000 | 13,200 | - | - | 4,800 | 8,400 |
| Coastal | 1,800 | 1,800 | 3,100 | - | - | 1,300 | 1,800 |
| Subtotal | 7,800 | 7,800 | 16,300 | - | - | 6,100 | 10,200 |
| Total | 174,400 | 128,000 | 442,500 | 46,400 | 146,500 | 257,500 | 331,500 |

Table 141 - Irrigation from Ground Water Sources, 1966, Subregion 10

| State | Irrigated Area (acres) | Adequate Supply Area (acres) | Adequate Supply Diversion (ac-ft) | Inadequate Supply Area (acres) | Inadequate Supply Diversion (ac-ft) | Return Flow (ac-ft) | Depletions (ac-ft) |
|---|---|---|---|---|---|---|---|
| Oregon | | | | | | | |
| Rogue River | 500 | 500 | 1,500 | - | - | 600 | 900 |
| Umpqua River | - | - | - | - | - | - | - |
| Coastal | 500 | 400 | 700 | 100 | 200 | 300 | 600 |
| Subtotal | 1,000 | 900 | 2,200 | 100 | 200 | 900 | 1,500 |
| Washington | | | | | | | |
| Chehalis River | 2,700 | 2,700 | 5,000 | - | - | 1,400 | 3,600 |
| Coastal | 2,900 | 2,500 | 3,100 | 400 | 300 | 1,100 | 2,300 |
| Subtotal | 5,600 | 5,200 | 8,100 | 400 | 300 | 2,500 | 5,900 |
| Total | 6,600 | 6,100 | 10,300 | 500 | 500 | 3,400 | 7,400 |

streamflows and over-appropriation and occur on tributaries that lack storage facilities. Private or individual developments without storage are most susceptible to these shortages. Most of the lands with water shortages are located in the Rogue subarea where nearly 33 percent of the irrigated lands have inadequate supplies.

Ground water supplies are inadequate for 500 acres using this source. Most of these water-short lands are located in the Long Beach Peninsula area in southwestern Washington.

## Application of Water

Except in the Rogue subarea, portable hand move sprinkler systems are the most widely used means of irrigation. In the Rogue, a majority of farms still use gravity methods although the trend is toward sprinkler systems. Water distribution works for gravity systems have been established for a long while in the Rogue subarea. The land irrigated from these works is fairly level and agricultural practices associated with gravity systems are a tradition. Thus, many farmers have not felt a need to go to the expense of converting to sprinklers.

Accurate control of water application, the labor-saving qualities of the sprinkler irrigation equipment, and the fact that sprinkler systems can irrigate lands too steep for practical gravity application are major reasons for the popularity of sprinklers in most of the subregion. The difficulty of maintaining headworks for gravity systems in the face of annual floods along the coastal streams is another reason that sprinkler systems are popular.

## Quality of Water

The history of irrigation shows no significant water quality problems either in surface or ground water supplies which would deter continued irrigation growth.

Although the proportion of total dissolved solids increases as streamflows diminish, water even from low streamflow is suitable for irrigation. The lower reaches of most coastal streams are affected by salt water intrusion. In addition to salt contamination from intrusion, oceanic aerosols increase the salt content of streams up to several miles inland. However, these aerosols have no effect on the quality of the water for irrigation use. Ground water quality is usually good although in some coastal areas it is poor for irrigation use because of high dissolved salt content.

The impact of irrigation on the quality of the subregion's water supply appears to be minimal. The most obvious potential for

stream pollution by irrigation is from return flow, but there are no known reports of adverse effects from this source. Analysis of samples indicates that much of the natural and applied minerals and chemicals are removed during the fall and winter when streamflows are generally high.

## FUTURE NEEDS

Expansion of irrigation in the subregion is necessary to assist in meeting the future regional food and fiber requirements. These future irrigation needs can be met by furnishing supplemental water where supplies are presently inadequate and a full water supply to newly irrigated farmland. There are more than 1.6 million acres of potentially irrigable lands. Of the 181,000 acres irrigated in 1966, some 46,900 acres are in need of supplemental supplies.

### Lands

Satisfaction of future food and fiber requirements is projected to require an increase in the irrigated area from 100,000 acres in 1966 to 280,000 acres by 1980, to 290,000 acres by the year 2000, and 330,000 acres by 2020. These figures, which are inclusive of all irrigated lands whether or not used for agriculture, are presented in table 142. Needs for irrigated lands producing agricultural products are identified by crop category in table 143.

Table 142 - Irrigated Area Needs by 1980, 2000, and 2020, Subregion 10

| Item | Irrigated Acreage 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|
| Harvested cropland and pasture 1/ | 238 | 246 | 280 |
| Other 2/ | 42 | 44 | 50 |
| Total irrigated area | 280 | 290 | 330 |

1/ From table 143.
2/ Includes irrigated forest, range, rights-of-way, ditches, roadways, farmsteads, urban, and idle irrigated lands not used in the production of projected crop requirements.

After satisfying 1980 needs, irrigated acreages are projected to increase at a lesser rate. Individual crop category acreage needs will generally increase slightly; however, decreases are projected

Table 143 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020, Subregion 10

| Crop Category | Acreage Needs 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|
| Small grains | 10 | 7 | 4 |
| All hay | 68 | 75 | 88 |
| Dry beans and peas | - | - | - |
| Sugar beets | - | - | - |
| Potatoes | - | - | - |
| Vegetables | 2 | 2 | 2 |
| Fruits, nuts, and berries | 29 | 22 | 20 |
| Forage seed, hops, and mint | 4 | 4 | 5 |
| Pasture | 102 | 111 | 133 |
| Unenumerated | 23 | 25 | 28 |
| Total | 238 | 246 | 280 |

for small grains and fruits with the vegetable acreage remaining constant.

## Production and Yield

Crop production from irrigated land is summarized in table 144. Crop yields for each projected crop category are shown in figure 51. The indexes can be used to show percentage increases projected from the base year of 1964 which was set at 100.

Table 144 - Crop Production from Projected Irrigated Acreage for 1980, 2000, and 2020, Subregion 10

| Crop Category | Units | Production 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|---|
| Small grain | tons | 18 | 16 | 10 |
| Hay | tons | 212 | 272 | 403 |
| Vegetables | cwt. | 306 | 355 | 446 |
| Fruits, nuts, and berries | tons | 182 | 219 | 289 |
| Forage seed, hops, and mint | lbs. | 3,558 | 4,174 | 6,425 |

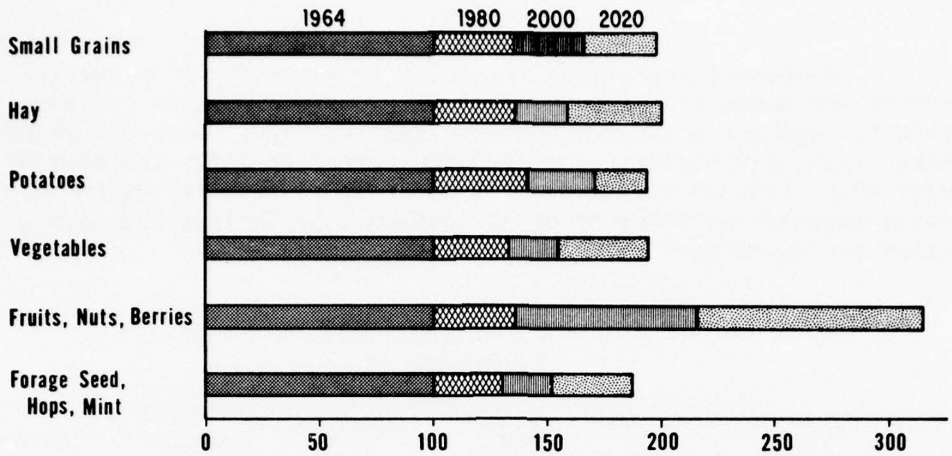



FIGURE 51. Yields for Selected Crops for 1980, 2000, and 2020 (1964 as Base Year Equals 100) Subregion 10.

## Value of Production

Projected values of irrigated crop production are presented in table 145. Irrigated crops consumed by livestock are included in these values. The values are based on projected production and the same price level used in the regional projections.

Table 145 - Value of Projected Irrigated Crop Production, Subregion 10

| Crop Category | Value of Production 1/ 1980 | 2000 ($1,000) | 2020 |
|---|---|---|---|
| Small grains | 1,000 | 800 | 500 |
| Hay | 4,600 | 5,800 | 8,700 |
| Dry beans and peas | - | - | - |
| Sugar beets | - | - | - |
| Potatoes | - | - | - |
| Vegetables | 900 | 1,100 | 1,300 |
| Fruits, nuts, and berries | 22,000 | 26,500 | 34,900 |
| Forage seed, hops, and mint | 700 | 900 | 1,300 |
| Total | 29,200 | 35,100 | 46,700 |

1/ Based on projected normalized prices.

## Water

Additional depletions resulting from meeting supplemental irrigation needs and irrigation of previously dry lands are expected to total approximately 241,000 acre-feet by 2020. This figure combined with 1966 depletions of 339,000 acre-feet indicates that by year 2020, 580,000 acre-feet will be depleted from Subregion 10 water supplies as a result of irrigation. Depletions and farm deliveries are summarized by time periods in table 146.

Table 146 - Projected Farm Deliveries and Depletions, Subregion 10

| Year | Presently Irrigated Farm Delivery | Presently Irrigated Depletion | Future Irrigation Farm Delivery | Future Irrigation Depletion | Total Farm Delivery | Total Depletion |
|---|---|---|---|---|---|---|
| | | | (1,000 ac-ft) | | | |
| 1966 | 451 | 339 | | | 451 | 339 |
| 1980 | 480 | 360 | 190 | 140 | 670 | 500 |
| 2000 | 480 | 360 | 210 | 150 | 690 | 510 |
| 2020 | 480 | 360 | 300 | 220 | 780 | 580 |

### Supplemental

To supply the inadequately irrigated lands, an additional annual diversion supply of 38,100 acre-feet needs to be developed. This will provide an additional farm delivery of 29,000 acre-feet and result in additional depletions of 21,000 acre-feet. The annual need is shown in table 147.

### Full

New lands expected to be irrigated by 2020 will require farm deliveries of 300,000 acre-feet and resulting depletions will amount to 220,000 acre-feet as shown in table 146.

The Coastal Subregion extends from California to Canada and from the Pacific Ocean to the interior Chehalis, Umpqua and Rogue Valleys. The major factors affecting irrigation water requirements in the subregion are precipitation and cloud cover which in turn affects solar radiation, temperature and evapotranspiration. Most cloudy air masses usually enter the region from the west with more entering along the north coast than along the southern coast. Therefore irrigation water requirements are smallest along the coast of Washington and highest in the Rogue Valley. Climatic variations

are reflected in the estimated farm delivery requirements and depletions shown in table 148.

Table 147 - Supplemental Irrigation Diversion Requirements
Subregion 10

| Subarea | Water-short Lands (acres) | Supplemental Requirement (acre-feet) |
|---|---|---|
| Oregon | | |
| Rogue River | 38,700 | 32,500 |
| Umpqua River | 4,900 | 4,300 |
| Coastal | 2,900 | 1,100 |
| Washington | | |
| Chehalis River | 0 | - |
| Coastal | 400 | 200 |
| Total | 46,900 | 38,100 |

Table 148 - Irrigation Requirements and Depletions
Subregion 10

| | Present-2000 | | 2000-2020 | |
|---|---|---|---|---|
| Subarea | Farm Delivery | Depletion | Farm Delivery | Depletion |
| | (AF/ac.) | | | |
| Oregon | | | | |
| Rogue | 3.0 | 2.3 | 3.5 | 2.6 |
| Umpqua | 2.8 | 2.1 | 3.4 | 2.5 |
| Coastal | 1.7 | 1.2 | 1.8 | 1.4 |
| Washington | | | | |
| Chehalis | 1.8 | 1.4 | 2.5 | 1.8 |
| Coastal | 1.2 | 0.9 | 1.5 | 1.1 |

## THE POTENTIAL TO MEET THE NEEDS

Subregion 10 has a water supply which far exceeds the amount needed if all the potentially irrigable lands were brought under irrigation. Projected needs show that by 2020 less than one-tenth of the potentially irrigable land will be required. Development of the needed acreage will require close cooperation of both Federal and private interests.

## Potentially Irrigable Lands

There are over 1.6 million acres of dry land suitable for irrigated agriculture, even though the best use may be for non-agricultural purposes. Much of this land is presently forested.

The 27 percent of the subregion which lies in Washington has a greater potentially irrigable acreage than does the Oregon section. The majority of the irrigable lands in Oregon are located in the Rogue and Umpqua Subareas. In Washington they are located along the coast. The location of the potentially irrigable lands is shown on figure 49. Table 149 presents the acreages by land class for the various subareas.

Table 149 - Potentially Irrigable Land, 1966, Subregion 10

| Subarea | Class 1 (acres) | Class 2 (acres) | Class 3 (acres) | Total (acres) |
|---|---|---|---|---|
| Oregon | | | | |
| Rogue | 18,700 | 142,400 | 167,800 | 328,900 |
| Umpqua | 18,800 | 88,700 | 116,400 | 223,900 |
| Coastal | 45,100 | 73,100 | 133,400 | 251,600 |
| Subtotal | 82,600 | 304,200 | 417,600 | 804,400 |
| Washington | | | | |
| Chehalis | 9,600 | 54,900 | 111,400 | 175,900 |
| Coastal | 25,600 | 235,000 | 382,800 | 643,400 |
| Subtotal | 35,200 | 289,900 | 494,200 | 819,300 |
| Total | 117,800 | 594,100 | 911,800 | 1,623,700 |

### Class 1

Class 1 lands total about 118,000 acres or about 7 percent of the irrigable area. Most of the soils in this class have developed on old alluvial terraces and recent alluvial flood plains. Topography is level to rolling and in some cases land would require additional leveling before gravity irrigation methods could be used.

Soils are friable, medium textured and moderately acid. Generally, they are deep and well drained though some drainage improvement could be effected by clearing natural drain channels and deepening shallow road culverts. These lands are suited to production

of any climatically adapted crops. Forage crops as well as small fruits and vegetables such as broccoli are successfully grown on the coast. The interior basins have even greater crop adaptability; for example, small grains and alfalfa do better here than they do on the coast.

Class 2

Class 2 lands total about 594,000 acres, 37 percent of the potentially irrigable land. Topography and location of these lands on old alluvial terraces and recent flood plains are similar to that of class 1 lands. However, class 2 lands may have imperfect natural drainage, or they may be finer textured and more difficult to till than class 1 lands. Their productivity under irrigation might be improved by installation of subsurface drainage.

These lands are of good quality and will grow most of the crops adaptable to class 1 though lower yields can be expected.

Class 3

Class 3 lands total about 912,000 acres or 56 percent of the potentially irrigable area. Some of the class 3 lands occupy low positions along streams and are subject to seasonal flooding. Some are located along minor drainageways where natural drainage is impeded. Some class 3 lands are steep or have shallow or stony soil. Some have fine textured soils formed from backwater deposits along flooding streams. Installation of surface drainage where natural drainways are inadequate and of subsurface drain tiles where soils are deep enough may be economically justified on some of the class 3 lands.

They are of fair crop-producing quality, but the range of crop output will be limited under irrigation. Present irrigated class 3 land use indicates that pasture will probably be the main irrigated land use of potentially irrigable class 3 lands. However, recent improvements in subsurface drainage methods indicate the possibility that some of these lands could have the capability, when they are properly managed, to produce crops similar to those grown on class 1 and 2 lands.

## Water Supply

Discharge of streams in the subregion averages about 63 million acre-feet annually. About 60 percent originates in Oregon and the remainder comes from Washington.

The quantity of water in the uppermost 50 feet below the water table is estimated at 14 million acre-feet in Oregon and

13 million acre-feet in Washington. Annual natural recharge is about 10 and 6 million acre-feet respectively in Oregon and Washington.

## Potential Developments

Subregion 10 has an adequate surface water supply to meet the long-range irrigation needs by 2020. An additional irrigation development of 150,000 acres will increase the total irrigation development of this subregion to 330,000 acres. To meet this long-range irrigation goal will require the close coordination of Federal and private enterprise.

### Developments by Subarea

Each of the four subareas has some potential for additional irrigation development. The 27 percent of the subregion within Washington has a greater amount of potentially irrigable lands than does the Oregon section. The majority of the irrigable lands in Oregon are located in the Rogue and Umpqua subareas; in Washington they are located in the Coastal subarea.

### Private Developments

Much of the present irrigation in the northern part of this subregion has been through private initiative. This is especially true along the coastal areas and it is anticipated that most of the new land development will continue to be developed on an individual farm basis.

Since the 1966 survey was made, it is estimated that 3,000 acres have been brought under irrigation by private means in the Coastal and Chehalis subareas. In the Umpqua and Rogue River subareas the amount of private development will be restricted because natural streamflows have been heavily appropriated and ground water supplies are scattered and limited.

### Federal Developments

Several Federal agencies are making intensive studies in the Rogue and Umpqua River subareas to determine the irrigation potential. Investigations indicate that storage on the South Umpqua River and on Olalla, Calapooya, and Cow Creeks would provide multiple-purpose developments in the Umpqua subarea which would permit the irrigation of over 30,000 acres of new land.

New multiple-purpose developments in the Rogue River subarea will depend on project-type developments with storage of surface flows. Dams are presently proposed on Rogue River and Applegate River and Jumpoff Joe Creek, Sucker Creek, Evans Creek, and Elk Creek. These potential storage projects could provide an adequate water supply to over 58,000 acres.

In the Chehalis River subarea, Federal studies have identified an area of about 85,000 acres that could be included in long-range plans for irrigation development. Other project-type irrigation potentials have been investigated in both Oregon and Washington along the coastal strip.

About 25 smaller project-type potential irrigation developments have been identified in the subregion which would irrigate about 122,000 acres. Numerous irrigation plans are now being investigated which would make more efficient use of existing water supplies and also consider the potential of diverting water from river basins with surplus water to areas with a limited water supply.


LOCATION MAP

# SUBREGION 11

# SUBREGION 11

# PUGET SOUND

## THE SETTING

The Puget Sound Subregion, located in the northwest portion of the State of Washington, includes all those lands south of the International Boundary that are drained by streams flowing into Puget Sound, Hood Canal, Georgia Strait, and that part of the Strait of Juan de Fuca east from and including the Elwha River. The total area of 8,547,200 acres is slightly less than 5 percent of the total region area.

The subregion lies astride the Puget Sound trough which is the northern portion of a long, north-south trending lowland known as the Willamette-Puget Sound Trough. The Puget Lowland is separated from the remainder of the trough by a low range of hills along the southern boundary of the subregion and is flanked on the east by the Cascade Mountains and on the west by the Olympic Mountains.

Precipitation in the lowland agricultural areas generally ranges from 30 to 40 inches annually. The exception is the West Sound area where annual precipitation ranges from 15 to 30 inches in the lowlands, due to the "rain shadow" effect of the Olympic Mountains. Although annual precipitation is high, summer precipitation is usually inadequate for optimum crop growth. Generally, available moisture from June through August averages about half the amount required for full crop production.

Average July temperatures generally range from 60°F. to 65°F. and average January temperatures range from 35°F. to 40°F. in the lowland areas. Average annual temperatures are generally about 50°F. The frost-free period ranges from 160 to 250 days throughout the lowlands.

More than 40 percent of the total annual runoff originating in the State of Washington occurs in this subregion. During the 1931-1960 period, annual runoff averaged 39 million acre-feet. The Skagit and Snohomish River systems account for nearly one-half of the subregion's annual runoff. In spite of this abundant overall supply, surface water may not be available in sufficient quantities when or where it is needed. In most of the subregion there is an abundant supply of ground water with only localized areas having limited supplies.

Agriculture started with earliest settlement. The Puget Sound Agricultural Company, a subsidiary of the Hudson's Bay Company, grazed cattle and sheep on the tall grass prairies in Pierce County about 1843. In most cases, agriculture was established to support logging, fishing, and mining activities.

The need for irrigation was apparent in some areas; in 1895, a group of farmers near Sequim, in the West Sound area, organized a ditch company and constructed irrigation facilities to divert water from the Dungeness River. By 1910, four irrigation projects were in operation. They were the Sequim, Eureka, Yelm, and Independent ditches, and all were cooperative landowner enterprises. In the early 1900's, a few small tracts were being irrigated in Pierce, King, and Thurston Counties. During the period 1900 to 1945, however, most irrigation remained concentrated in the lower Dungeness and Nisqually River valleys. There were 6,100 acres irrigated in 1919 and 10,300 acres irrigated in 1945.

Since 1945 the irrigated acreage has increased significantly in a number of localities; the largest growth occurred in the Nooksack Valley north of Bellingham. A readily available water supply in past years was a significant factor in irrigation growth because it facilitated individual development as well as cooperative and group enterprise.

Because of the geographic nature of the subregion, agricultural lands are limited in their extent. Those areas lying near expanding population centers are being converted to industrial and urban uses. Farm operators have been required to manage and use the available cropland more intensively to meet the increasing demand for agricultural products.

The subregion has been divided into three subareas for discussion as shown in figure 52. The North Sound includes those lands in the Snohomish River drainage together with those lands northward to the United States-Canada International Boundary and including the San Juan Islands. The South Sound includes those lands south of the Snohomish River drainage and including those lands around the southern part of the Puget Sound and Hood Canal. The West Sound includes lands in the northeast corner of the Olympic Peninsula and Whidbey and Camano Islands.

## PRESENT STATUS

The subregion ranks eleventh in the region in terms of irrigated area, all of which has been developed through private initiative. Study surveys identified an irrigated area of 92,000 acres in 1965 and 1966. Included is a small acreage devoted to irrigated forest nurseries and seed orchards, recreation sites, and minor tracts used for wildlife and other purposes.

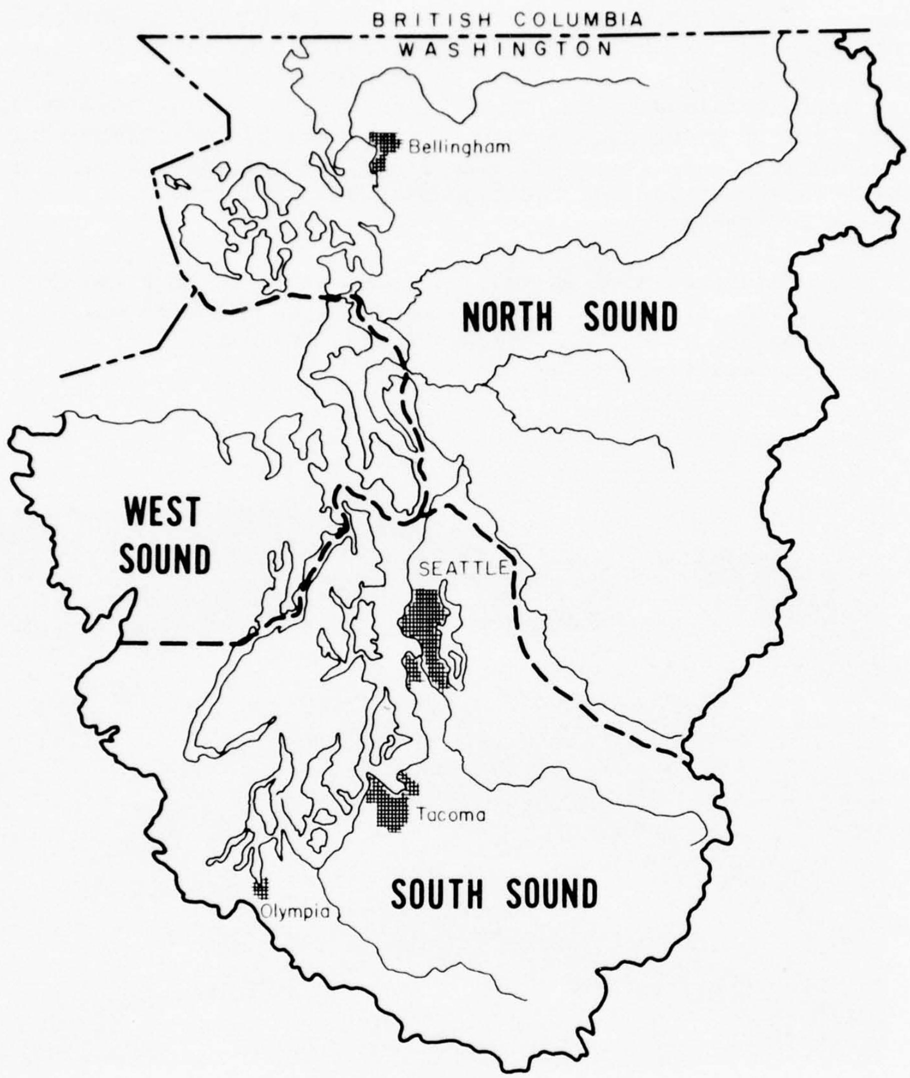



FIGURE 52. Subareas in Subregion 11, Puget Sound

Some of the lands identified are not irrigated every year since the number of acres irrigated in any one year depends on the amount of summer rainfall. It is estimated that an area of about 68,000 acres is normally irrigated in a year having average precipitation during the growing season. Of the irrigated area identified in 1965-1966, 35,000 acres are estimated to be served from ground water sources and 57,000 acres from surface water sources. These acreages, by source of supply, are generally intermingled throughout the subregion.

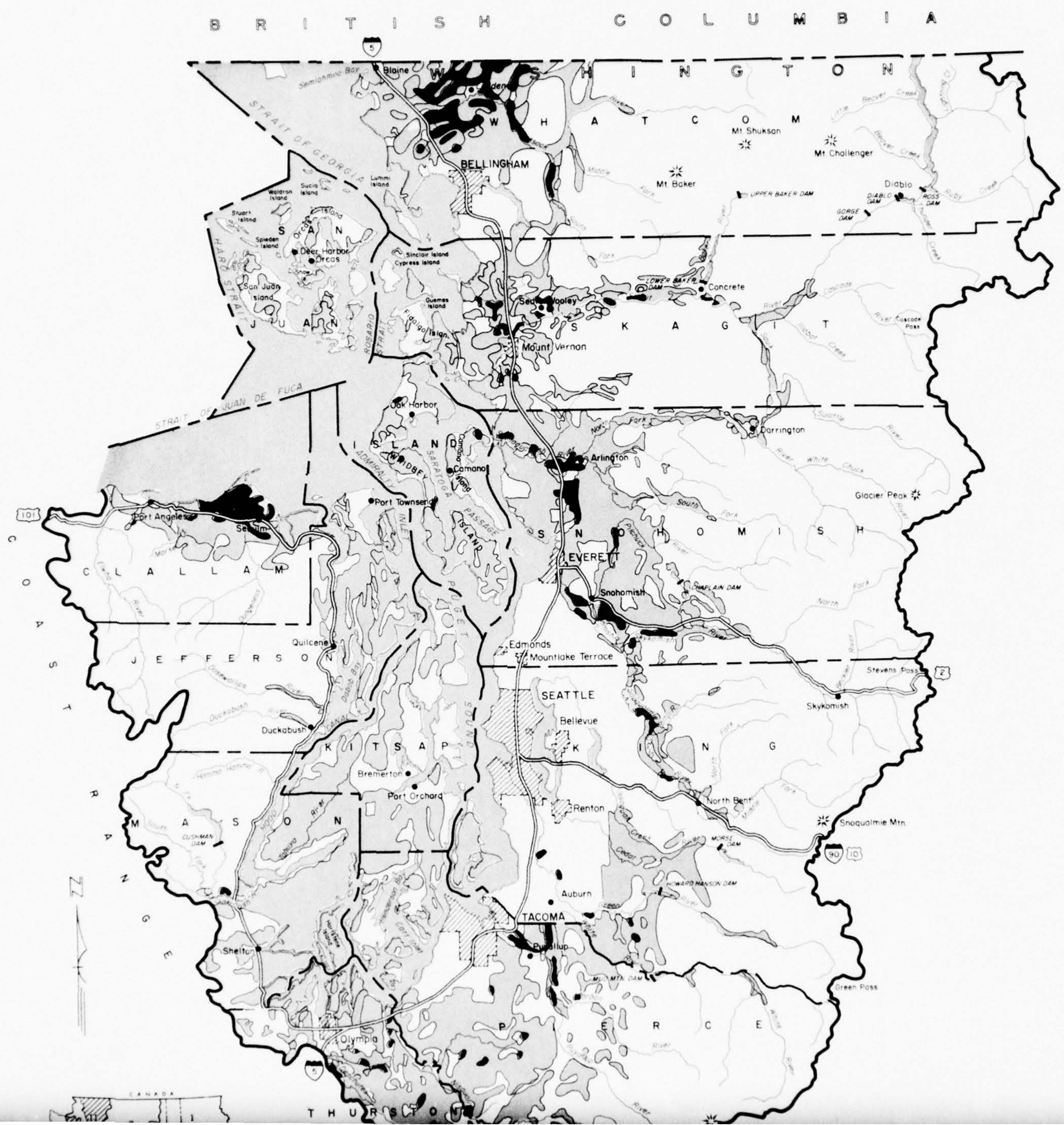
## Characteristics of Irrigated Areas

Figure 53 shows the location of the irrigated area identified in 1965-1966, with the exception of tracts too small to appear at map scale; they are generally interspersed with larger areas of nonirrigated land. The largest concentrations, as shown on figure 53, are located along the Nooksack River north of Bellingham where 38,400 acres are irrigated; the Elwha and Dungeness River valleys, with 15,900 acres; and the Snohomish River valley, with 12,800 acres irrigated.

Data presented on number, type, and size of farms were derived from the 1964 Census of Agriculture for Clallam, Island, Jefferson, King, Kitsap, Mason, Pierce, San Juan, Skagit, Snohomish, Thurston, and Whatcom Counties.

*The major use of irrigated cropland is for production of feeds and forages to support livestock operations. (Bureau of Reclamation)*

In 1964, there were about 1,190 farms with irrigated land; this number represents about 8 percent of the subregion's 14,488 farms. The average farm with irrigated land had about 30 acres irrigated out of a 110-acre total. Based on irrigated land use and other census data, dairy and other livestock farms constituted the majority of farms with irrigated land. Some 85 percent of irrigated cropland was devoted to the production of pasture, hay, and silage crops to support these livestock herds. Fruit and vegetable farms



BRITISH COLUMBIA
WASHINGTON
WHATCOM
SAN JUAN
SKAGIT
ISLAND
SNOHOMISH
CLALLAM
JEFFERSON
KITSAP
KING
MASON
PIERCE
THURSTON
COAST RANGE
STRAIT OF GEORGIA
HARO STRAIT
ROSARIO STRAIT
STRAIT OF JUAN DE FUCA
ADMIRALTY INLET
SARATOGA PASSAGE
PUGET SOUND
Blaine
BELLINGHAM
Mt Baker
Mt Shuksan
Mt Challenger
Diablo
UPPER BAKER DAM
LOWER BAKER DAM
Concrete
Sedro Wooley
Mount Vernon
Oak Harbor
Whidbey Island
Camano Island
Port Townsend
Port Angeles
Sequim
Darrington
Arlington
Glacier Peak
EVERETT
Snohomish
Edmonds
Mountlake Terrace
Quilcene
Duckabush
SEATTLE
Bellevue
Bremerton
Port Orchard
Renton
North Bend
Skykomish
Stevens Pass
Snoqualmie Mtn
Auburn
TACOMA
Puyallup
Shelton
Olympia
Green Pass
CANADA


POTENTIALLY IRRIGABLE AREA

CLASS 1

CLASS 2

CLASS 3

PRESENTLY IRRIGATED AREA

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# IRRIGATED AND POTENTIALLY IRRIGABLE AREAS

PUGET SOUND, SUBREGION 11

1968

FIGURE 53

2

were also leading farm types with irrigated acreages. Figure 54 shows the amount and relative percentages of the leading irrigated crops harvested and irrigated pasture for Subregion 11.


FIGURE 54. Acreages of Irrigated Cropland Harvested and Pasture, 1964, Subregion 11.

## Production of Irrigated Crops

A summary of crop production is presented in table 150. A higher percentage of production from the category containing hops, mint, and forage seed is grown under irrigation than any other category. About 96 percent of these crops are irrigated. However, even though only 22 percent of hay production came from irrigated land, it is the most important irrigated crop from the standpoint of acreage use. Crop yields for selected major irrigated crops are presented in table 151.

Table 150 - Summary of Crop Production, 1964, Subregion 11

| Crop Category | Units | Production (1000's) Total | Production (1000's) Irrigated | Percent Irrigated |
|---|---|---|---|---|
| Small grains | tons | 11 | -- | 0.0 |
| All hay | tons | 294 | 66 | 22.4 |
| Dry beans and peas | cwt. | 12 | -- | 0.0 |
| Potatoes | cwt. | 793 | 8 | 1.0 |
| Vegetables | cwt. | 2,254 | 86 | 3.8 |
| Fruits, nuts, and berries | tons | 29 | 6 | 20.6 |
| Forage seed, hops, and mint | lbs. | 28 | 27 | 96.4 |

Source: Derived from Census of Agriculture and Agricultural Statistics.

Livestock production is enhanced by the added feed crops grown on irrigated land. Irrigated pasture provides much of the summer grazing and irrigated hay and silage crops provide feed for maintaining animals producing livestock products and for wintering

Table 151 - Yields of Selected Major Irrigated Crops, 1964, Subregion 11

| Crop | Units | Yield per Irrigated Acre |
|---|---|---|
| Hay | tons | 4.5 |
| Corn silage | tons | 19.8 |
| Snap beans | cwt. | 126 |
| Sweet corn | cwt. | 112 |
| Strawberries | tons | 4.5 |
| Mint oil | lbs. | 57 |

breeding stock. It was estimated that in 1964 about 5 percent of the total livestock feed requirement was met by irrigation. The amount of irrigation in this subregion varies depending on rainfall. In normal rainfall years it has been estimated that about 18 percent of total livestock feed requirements are met by production from irrigated land.

## Value of Production

The value of production from irrigated land was estimated for a normal rainfall year. Total crop, livestock, and livestock products associated with irrigation were estimated at $18 million. Irrigated crops excluding feed crops consumed by livestock accounted for $8 million with the remainder being associated with livestock.

Irrigated berry production accounts for nearly 60 percent of the crop value with vegetable production accounting for another 30 percent. Milk is the highest valued livestock product accounting for 80 percent of the total value associated with livestock supported from irrigated feed production.

## Economic and Social Impacts from Irrigation

The gross value of products and services normally derived from irrigation use is shown in table 152. It is estimated that irrigation use generates economic values more than double the value of sales of irrigated agricultural products. Part of this is brought about by the increased volume of agricultural products processed or otherwise handled because of irrigation. The remainder is the result of additional business activity generated by the increased demand for goods and services by farmers, processors, and those businesses serving them.

Table 152 - Normal Gross Value of Agricultural Products, Services, and Employment Associated with Irrigation Use, Subregion 11

| Industry | Gross Value ($1,000,000) | Employment Generated (Man-years) |
|---|---|---|
| Basic Agriculture | 17.6 | 1,200 |
| Processing | 14.2 | 400 |
| Trades and Services | 28.4 | 1,800 |
| Total | 60.2 | 3,400 |

Agricultural labor needs are greatly increased because of irrigation use, and labor needs in the processing and trades and services industries are normally increased even more as a result of irrigation. Table 152 shows that irrigation normally increases employment 1.8 times as much in the processing and trades and services sectors as it does on the farm.

*High seasonal labor requirements are characteristic of such crops as irrigated strawberries. (Bureau of Reclamation)*

## Use of Water

There were 92,000 acres in the subregion that were developed for irrigation in 1966. However, since only 68,000 acres would have been irrigated in an average year, present irrigation water use is based on the smaller figure. Water use would be about 35 percent greater if all 92,000 acres were irrigated. Estimated water use is shown by subareas in table 153.

Table 153 - Estimated Irrigated Area Served from Surface and Ground Water Sources, Subregion 11

| Subarea | Area Irrigated 1/ (acres) | Average Annual Diversion (ac-ft) | Average Return Flow (ac-ft) | Average Annual Depletion (ac-ft) |
|---|---|---|---|---|
| North Sound | 38,000 | 73,000 | 20,000 | 53,000 |
| South Sound | 13,000 | 29,000 | 10,000 | 19,000 |
| West Sound | 17,000 | 79,000 | -- | 79,000 |
| Total | 68,000 | 181,000 | 30,000 | 151,000 |

Source: Puget Sound and Adjacent Waters Comprehensive Water Resource Study (unpublished).

1/ Average water-use year.

Irrigation diversions for 68,000 acres are estimated to total 181,000 acre-feet. About two-thirds come from surface sources and the remainder from ground water. Of the 92,000 acres developed for irrigation in 1966, 57,000 acres obtain water from surface sources and 35,000 acres use ground water.

Return flows to surface and ground water sources are estimated to total 30,000 acre-feet annually. Other return flows, estimated at about 30,000 acre-feet, drain into Puget Sound and Strait of Juan de Fuca from adjacent lands. Since these return flows are not available for reuse, they are considered as a depletion. Total depletions, therefore, amount to 151,000 acre-feet.

## Adequacy of Supply

With few exceptions, the quantity of water available in the subregion is adequate to meet present irrigation needs. The average shortage is negligible. Those irrigators obtaining their supply from high altitude watersheds benefit from sustained summer streamflows. Irrigators diverting water from streams originating in the

lower basins may have inadequate supplies during unusually low-flow years.

The Dungeness River is the only stream that has been adjudicated in the subregion. Although the adjudication allows 29,000 acres to be irrigated, the number of acres actually irrigated (some 15,500 acres) is at a level that can be adequately served from the Dungeness River under present practices. Irrigation shortages could occur near the mouth of the river in a repetition of critically dry years.

Generally there is an abundant supply of ground water throughout the subregion; any shortages from this source are of a local nature.

## Application of Water

Most irrigators use the sprinkler method of application. The water is pumped directly into the farm sprinkler systems from surface sources or wells. It is estimated that in any one year an average of only about 1,000 acres are irrigated by gravity application. Portable hand move systems are the most widely used in the subregion. However, solid set and wheel roll systems are becoming more important each year. In the future, as the available labor supply dwindles, these more sophisticated systems will play a bigger role in irrigation development.

## Quality of Water

The quality of surface waters in the subregion is excellent for irrigation as evidenced by analyses of samples taken and many years of irrigation use. High sediment rates are associated with periods of high runoff; however, few sediment problems have been reported in connection with irrigation use.

The quality of ground water is generally good for irrigation, although it is more highly mineralized than the surface waters. Iron is the most objectionable constituent in some ground water sources, but it has no adverse effect on irrigation.

In isolated instances near the Puget Sound, ground water sources are influenced by sea water intrusion. In addition, isolated inland occurrences of high concentrations of total dissolved solids are attributed to production from ground water aquifers located in older marine sediments. These two problems could have an adverse effect on the use of some ground water supplies for irrigation.

## FUTURE NEEDS

Development of additional irrigated land in this subregion will be required to help meet the region's food and fiber requirements. About 220,000 irrigated acres are projected to be needed by 2020, an increase of approximately 130,000 acres above the present. There are about 1.5 million acres potentially irrigable and enough water to meet any future irrigation requirement.

### Lands

The projected irrigated area needs for Subregion 11 are presented in table 154. These acreages are consistent with satisfying future food and fiber requirements. They are based on projected productive irrigated land adjusted to include other irrigated lands not used in the production of crops and pasture. A summary of productive irrigated lands is presented by crop category in table 155. Vegetables and pasture are the principal users of irrigated land and are projected to continue as such.

Table 154 - Irrigated Area Needs by 1980, 2000, and 2020, Subregion 11

| Item | Irrigated Acreage | | |
|---|---|---|---|
| | 1980 | 2000 (1000's) | 2020 |
| Harvested cropland and pasture 1/ | 119 | 162 | 187 |
| Other 2/ | 21 | 28 | 33 |
| Total irrigated area | 140 | 190 | 220 |

1/ From table 155.
2/ Includes irrigated forest, range, rights-of-way, ditches, roadways, farmsteads, urban, and idle irrigated lands not used in the production of projected crop requirements.

### Production and Yield

Crop production from projected acreages is summarized in table 156. Crop yields on which the production was based are illustrated in index form by crop category on figure 55. The indexes are based on 1964 yields equaling 100. No irrigated hay production is indicated until the year 2020. This occurs because nonirrigated production can supply all of the requirements until then.

Table 155 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020, Subregion 11

| Crop Category | Acreage Needs 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|
| Small grains | 2 | 3 | 3 |
| All hay | - | - | 4 |
| Potatoes | 6 | 6 | 6 |
| Vegetables | 34 | 46 | 56 |
| Fruits, nuts, and berries | 5 | 7 | 6 |
| Pasture | 55 | 76 | 85 |
| Unenumerated | 17 | 24 | 27 |
| Total | 119 | 162 | 187 |

*The subregion is a major producer of fresh berry crops such as raspberries. (Bureau of Reclamation)*

Table 156 - Crop Production from Projected Irrigated Acreage for 1980, 2000, and 2020, Subregion 11

| Crop Category | Units | Production 1980 | (1000's) 2000 | 2020 |
|---|---|---|---|---|
| Small grain | tons | 3 | 6 | 8 |
| Hay | tons | - | - | 19 |
| Potatoes | cwt. | 1,256 | 1,513 | 1,164 |
| Vegetables | cwt. | 3,358 | 5,933 | 9,495 |
| Fruits, nuts, and berries | tons | 19 | 38 | 48 |

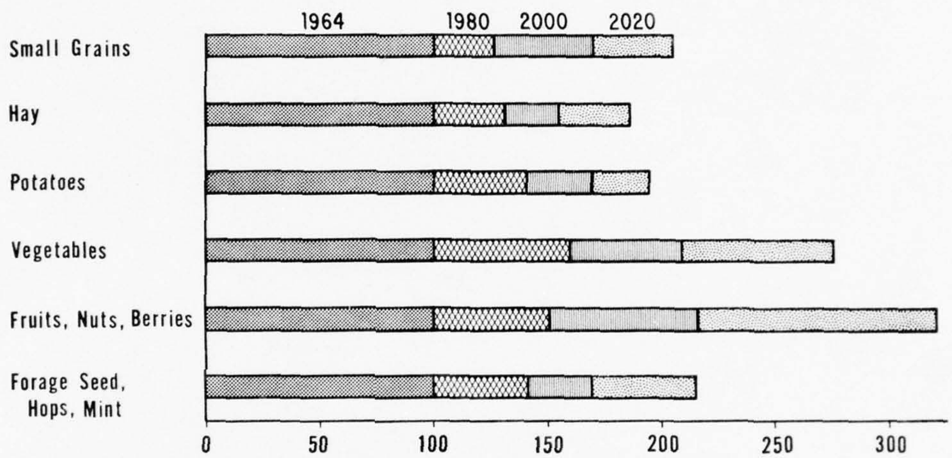



FIGURE 55. Yields for Selected Crops for 1980, 2000, and 2020 (1964 as Base Year Equals 100), Subregion 11.

## Value of Production

Projected values of irrigated crop production are presented in table 157. The values of irrigated crops consumed by livestock are included. The same price structure as that established by OBERS in the regional projections along with projected irrigated production determined the values.

## Water

An additional 298,000 acre-feet of water will be required at the farm to meet dry-year requirements of the presently irrigated lands and requirements of the new lands expected to be irrigated by

Table 157 - Value of Projected Irrigated Crop Production, Subregion 11

| Crop Category | Value of Production 1/ 1980 | 2000 ($1,000) | 2020 |
|---|---|---|---|
| Small grains | 200 | 300 | 400 |
| Hay | - | - | 400 |
| Potatoes | 1,700 | 2,000 | 1,600 |
| Vegetables | 10,000 | 17,600 | 28,200 |
| Fruits, nuts, and berries | 2,300 | 4,600 | 5,800 |
| Total | 14,200 | 24,500 | 36,400 |

1/ Based on projected normalized prices.

2020. Depletions resulting from the new water supply will total 259,000 acre-feet. Estimated farm deliveries and depletions are shown by time periods in table 158.

Table 158 - Projected Farm Deliveries and Depletions, Subregion 11

| | Presently Irrigated | | Future Irrigation | | Total | |
|---|---|---|---|---|---|---|
| Year | Farm Delivery | Depletion | Farm Delivery | Depletion | Farm Delivery | Depletion |
| | | | (1,000 ac-ft) | | | |
| 1966 | 142 | 151 | | | 142 | 151 |
| 1980 | 180 | 180 | 90 | 90 | 270 | 270 |
| 2000 | 180 | 180 | 180 | 160 | 360 | 340 |
| 2020 | 180 | 180 | 260 | 230 | 440 | 410 |

Supplemental

Although there are adequate water supplies for the entire 92,000 acres developed for irrigation in 1966, only 68,000 acres are estimated to be irrigated in an average year. Projected irrigation water use is based on dry-year conditions and therefore includes requirements for some 24,000 acres that are not irrigated in an average year. Of these developed lands not irrigated in 1966, 22,000 acres are located in the North Sound subarea and the remaining 2,000 acres are located in the West Sound subarea. Estimated water use for these lands is shown in the following tabulation:

| Item | Acre-feet |
|---|---|
| Diversion | 47,000 |
| Return flow | 13,000 |
| Depletion | 34,000 |
| Farm delivery requirement | 43,000 |

Full

The irrigated area is expected to increase by 128,000 acres by 2020. An additional 260,000 acre-feet of water will be required at the farm to meet their needs. Depletions resulting from the new water supply will total about 230,000 acre-feet. The high depletion results from a large amount of return flow draining into Puget Sound and adjacent waters as it does for the presently irrigated lands.

Anticipated future water use is based on farm delivery requirements which were estimated for *Puget Sound Type II Studies.* Requirements are highest in the West Sound Subarea because of the rain shadow effect of the Olympic Mountains. Requirements are smallest in the North Sound Subarea because of the higher latitudes.

Water requirements in the Puget Sound Subregion generally increase progressing from the Nooksack and Sumas basins in the North Sound to the Nisqually and Deschutes basins in the South Sound. The irrigation water requirements in the North and South Sound subareas generally vary considerably from year to year depending upon the amount of precipitation that occurs during the growing season. Because of the marine influence, considerable precipitation is generally available toward meeting the consumptive use requirements of the crops grown. Irrigation is usually needed in later summer, however.

The irrigation requirement in the West Sound Subarea is considerably higher. This area is in the rain-shadow of the Olympic Mountains. Much of the area only receives about 20 inches of rainfall annually, making it comparable to some areas east of the Cascade Mountains.

Estimated unit depletions include varying evapotranspiration losses as well as estimated return flow draining into Puget Sound. Estimated farm delivery requirements and depletions are shown in table 159.

## THE POTENTIAL TO MEET THE NEEDS

There are 1,520,000 acres of potentially irrigable lands in the subregion and an average annual runoff of 38 million acre-feet. By 2020, 220,000 acres are expected to be irrigated, which would deplete the subregion's water supply by 259,000 acre-feet.

Table 159 - Irrigation Requirements and Depletions
Subregion 11

| Subarea | Farm Delivery Requirement (AF/ac.) | Depletion (AF/ac.) |
|---|---|---|
| North Sound | | |
| Nooksack-Sumas | 1.81 | 1.29 |
| San Juan Islands | 1.82 | 1.92 |
| Skagit-Samish | 1.82 | 1.86 |
| Stillaguamish | 1.82 | 1.33 |
| Snohomish | 1.82 | 1.33 |
| South Sound | | |
| Cedar-Green | 2.04 | 1.45 |
| Puyallup | 2.25 | 1.55 |
| Nisqually-Deschutes | 2.25 | 1.55 |
| Kitsap | 2.42 | 1.76 |
| West Sound | | |
| Clallam Peninsula | 2.42 | 1.76 |
| Elwha-Dungeness | 2.60 | 2.74 |
| Whidbey-Camano Islands | 2.60 | 2.74 |

Source: Puget Sound and Adjacent Waters Type II Study information.

Water supplies for future irrigation can be developed economically in most parts of the subregion by individual means. In a few areas project-type development is probably the best way of bringing the potentially irrigable lands under irrigation.

## Potentially Irrigable Lands

Land classification surveys identified about 1,520,000 acres of potentially irrigable land, which represents approximately 18 percent of the subregion's total land area.

About 55 percent of the potentially irrigable lands consist of forest lands and cut-over forest lands, some of which are being used for grazing. The remaining 45 percent are cleared for cropland use. Generally, the potentially irrigable lands in the subregion would be best suited to sprinkler application and would be capable of producing a wide variety of crops under irrigation farming.

The Puget Sound and Adjacent Waters Type II Study identified only 424,300 acres as potentially irrigable. The current study identified an ultimate potentially irrigable acreage by classifying all lands regardless of elevation, which was not the case in the Type II Study. Also, distance from a water source was not a factor

as to irrigability and all tree-covered lands with an irrigation potential were included in this study.

The location of the potentially irrigable land is shown on figure 53. Table 160 presents the acreages by land class for the various subareas and a discussion of each class follows.

Table 160 - Potentially Irrigable Land by Subarea
Subregion 11

| Subarea | Class 1 | Class 2 | Class 3 | Total |
|---|---|---|---|---|
| | | (acres) | | |
| North Sound | 20,480 | 119,920 | 456,270 | 596,670 |
| South Sound | 6,460 | 36,510 | 667,530 | 710,500 |
| West Sound | 2,380 | 61,540 | 148,520 | 212,440 |
| Total | 29,320 | 217,970 | 1,272,320 | 1,519,610 |
| Rounded | 29,300 | 218,000 | 1,272,300 | 1,519,600 |
| Percent of total | 2 | 14 | 84 | 100 |

## Class 1

Class 1 lands total some 29,300 acres or nearly 2 percent of the irrigation potential. Of this amount, about 20,480 acres, or nearly 70 percent, are located in the North Sound subarea.

These lands are the most suitable for irrigation development and are capable of producing a wide variety of hay, silage, and pasture crops; small grains; field crops, fruit and berry crops; and vegetable crops. They are nearly level and would be suited to either gravity or sprinkler application.

The class 1 lands have easily worked soils more than 40 inches deep with surface textures ranging from silt loams through loams to fine sandy loams. Gravel, cobble, or stones are not present in the tillage zone in amounts that would interfere with cultivation. These soils also have good permeability and water-holding capacities. Seepage or salt problems are not expected to develop under irrigation. There are no impermeable barriers within 8 feet of the surface that would restrict the downward movement of water.

## Class 2

Class 2 lands total about 218,000 acres and represent slightly more than 14 percent of the potentially irrigable lands. Of this

amount, 119,920 acres or 55 percent are in the North Sound. About 61,540 acres are in the West Sound subarea and some 36,510 acres in the South Sound subarea.

These are good quality lands with only moderate limitations to irrigation development. With proper management, these lands are capable of producing a wide variety of those crops grown in the subregion. The topography ranges from nearly level bottom lands to rolling uplands with slope gradients up to 12 percent. The more level class 2 lands would be well suited to either gravity or sprinkler application, whereas sprinkler application would be the most suitable for the more sloping lands.

Soil depths range from 20 to 40 inches and silt loams and loams are the most common surface textures. Although many of the soils in this class have reduced water-holding capacities due to gravel and cobble in the soil profile, their presence causes few, if any, tillage problems. Clayey or compacted subsoils do occur locally throughout the subregion to the extent that moderate farm drainage is required to maintain water tables below the root zone during the growing season. Few, if any, soils are affected by high concentrations of harmful salts. Impermeable barriers occur at least 6 feet below the surface on all class 2 lands.

Class 3

Class 3 lands total about 1,272,300 acres or nearly 84 percent of the subregion's total irrigation potential. Some 667,530 acres (52 percent of the class 3 potential) occur in the South Sound, while 456,270 acres are in the North Sound and 148,520 acres are in the West Sound. Included with the class 3 land are about 4,400 acres having irrigation potential for forest nurseries, seed orchards, seed production areas, recreation sites, and special range and wildlife areas.

Class 3 lands have more severe limitations as to irrigation development than class 1 or class 2 lands and many of them are marginal for the production of some crops presently grown in the subregion. The more seriously limited lands would be restricted to the production of hay and pasture crops. The topography of the class 3 lands ranges from nearly level to rolling with slope gradients up to 20 percent. Gravity application would be suitable for the more level lands; however, sprinkler application would be more practical on the sloping lands.

Soil depths range from 10 to 20 inches and surface textures include loamy sands and clays in addition to loams. Gravelly and cobbly profiles are more common with class 3 lands and, where associated with sandy-textured soils, severely limit water- and fertility-holding capacities of the soils. Some gravelly subsoils

are cemented and inhibit drainage, whereas others are quite porous and permit excessive drainage. In all cases impermeable barriers are at least 6 feet below the surface.

Farm drainage practices are needed on some clayey bottom land soils in order to maintain water tables below the root zone during wet seasons. Also, some bottom lands are subject to flooding. Areas of harmful salt concentration are few on class 3 lands and present no major problem to irrigation development.

### Water Supply

Average annual discharge of streams in the subregion is estimated to be about 38 million acre-feet, of which about 700,000 acre-feet enter from Canada.

Approximately 40 million acre-feet of ground water are stored in the uppermost 50 feet of the ground water aquifer. Annual natural discharge from the aquifer is about 11 million acre-feet. Local overdevelopment has been reported in a few small areas where salt water has entered wells drilled near the shores of Puget Sound.

### Potential Developments

Subregion 11 has an adequate surface water supply to meet any future need for irrigation far beyond the year 2020. About 220,000 acres need to be irrigated by 2020. Private enterprise and initiative will develop most of the early action requirement when surface water can be readily diverted and ground water pumping can be developed. Project-type developments are planned to meet long-range irrigation needs.

#### Development by Subarea

North Sound The greatest annual streamflow and the potential for the largest percentage of additional irrigation development in Subregion 11 exists in this subarea. Most of these lands are widely scattered throughout the Nooksack-Sumas and Skagit-Samish River basins.

South Sound Large ground water aquifers lie beneath much of this subarea, and in general, the surface water supply is adequate for additional irrigation development.

This subarea contains the large urban complexes, and it is estimated that additional urban expansion will encroach upon agricultural lands; consequently, irrigation development is projected to decrease in those particular areas.

West Sound Improved utilization of the surface water supplies will be necessary to expand irrigation development in this subarea. The largest concentrations of irrigable lands are located on the Clallam Peninsula and in the Elwha-Dungeness River Basins.

## Private Developments

Virtually all of the subregion's presently irrigated land has been accomplished through private financing, most of which has been developed by using surface flows from streams located in Nooksack-Sumas, Skagit-Samish, and Elwha-Dungeness drainage basins. It is anticipated that a major part of the early action project irrigation development will continue to be accomplished in these basins by individual farmers except for an area in the Elwha-Dungeness basin where a cooperative project is being proposed. These additional land developments will be irrigated from both ground water and surface supplies.

*Fertile bottom lands such as these are well suited to irrigation development. (Bureau of Reclamation)*

## Federal Developments

Project-type development includes plans to provide an adequate and dependable water supply to about 19,000 acres surrounding the town of Sequim. The plan proposes to divert natural flows from the Dungeness River into gravity canals leading to regulating reservoirs. Water would then be delivered to the irrigable lands through a pipe distribution system at a pressure which would permit sprinkler irrigation.

Development of over 4,000 acres along the Nisqually River would also require a cooperative effort that could best be developed through a project-type plan. This plan would utilize ground water pumping to sprinkler irrigate the area.

LOCATION MAP

# SUBREGION

# 12

# SUBREGION 12

# OREGON CLOSED BASIN

## THE SETTING

The Oregon Closed Basin, a 17,900 square mile area, is about 6.5 percent of the regional area. It includes most of Harney and Lake Counties in South-Central Oregon. The Steens Mountains in the southeast, the mountainous area south and west of Abert and Summer Lakes, and the southern part of the Blue Mountains in the northeast form the most rugged parts of the subregion. The Closed Basin is the northwest extension of the Great Basin geologic province and has many of its prominent features, such as fault block mountains like the Steens. All of the streams in the subregion empty into brackish internal lakes.

*Fort Rock, in the western part of the subregion, dominates the surrounding rangeland. (Oregon State Highway Commission)*

The elevation of the lava plain, which is about 4000 feet at its lowest point, contributes to the climatic extremes of the subregion. Summers are warm with recorded temperatures as high as 109°F.; winters are long and cold with temperatures recorded to an extreme low of -54°F. There is no real frost-free season as freezing temperatures may occur in any month, but in farming areas growing seasons generally vary from 90-120 days. Precipitation in the agricultural areas ranges from 7 to 12 inches annually.

The only significant perennial streams are the Silvies River, Donner and Blitzen River, Chewaucan River, Trout Creek, Deep Creek, Honey Creek, and two Silver Creeks. One Silver Creek supplies Thompson Reservoir in the western part of the subregion; the other in the northeast, drains into Harney Lake. Heaviest stream runoff is in the spring.

The natural vegetation gives a grey-blue cast to the countryside. Sagebrush and grass blend with bitterbrush and rabbitbrush and the drought-resistant juniper tree is common in many areas. The occasional buttes, cinder cones, gulleys, broken lava flows, and surrounding mountains relieve what otherwise is a flat vista of rangeland. Over three-fourths of the subregion's area is occupied by this rangeland.

The subregion has two major Federal wildlife refuges, the 185,000-acre Malheur National Wildlife Refuge about 20 miles south of Burns, and the 240,000-acre Hart Mountain Antelope Refuge in the south-central part of the subregion. The Malheur Refuge, surrounding Malheur Lake (into which the Silvies River drains) and Harney Lake, is noted as a nesting site for migratory birds.

With a 1965 population of 13,300, settlement of the subregion is sparse, amounting to less than one person per square mile. Only two towns have populations exceeding 500. These are Burns, with about 4,000, and its neighbor, Hines, with 1,400. Although lying just west of the subregion's boundary, Lakeview in Lake County with its population of 3,200 plays a role in the economy of the western part of the subregion.

Federal and state highways and local gravelled roads and a rail line between Burns and the Snake River Valley provide the primary transportation links.

The lumber industry and agriculture are the two major sources of revenue in the subregion. Some 90 percent of the manufacturing employment is in forest product processing. Timber is processed at Hines and Seneca in the northeast, at Paisley in the southwest and at Lakeview. Only a small area in the north and southwest and a band along the western border of the subregion produce significant stands of commercial timber.

*Sandhill cranes gather in a Malheur Wildlife Refuge meadow. (Oregon State Highway Commission)*

The primary emphasis of agriculture is on the livestock industry. Ranches which specialize in beef production are scattered throughout the area. This extensive grazing began in the late 1860's. As time passed, poor management caused the range to deteriorate so that presently it will support an average of only one cow per 30 acres.

Nearly 75 percent of the subregion is Federally administered. Less than 4 percent of the area is classed as cropland and most of this is irrigated to some extent. Accent is on forage crops to support the livestock industry. The uncertainty of water supplies from year to year causes many farmers to hold a full season's hay against the possibility of crop failure the next season. Although the proportion of land in crops is low, it is very important to the local economy because 45 percent of the forage required in the subregion is raised there on irrigated land.

Three subareas have been identified. The largest, covering more than 75 percent of the subregion, is Summer Lake-Malheur Lake. The others are Upper Silvies River and Alvord Lake. Figure 56 shows their location.

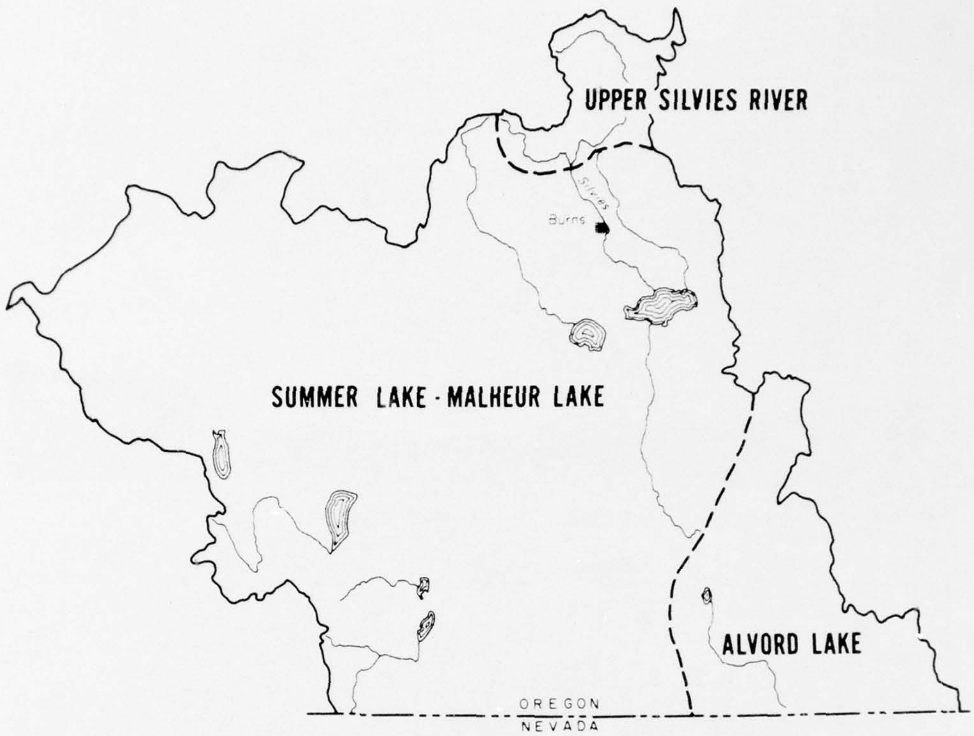



FIGURE 56. Subareas in Subregion 12, Oregon Closed Basin.

## PRESENT STATUS

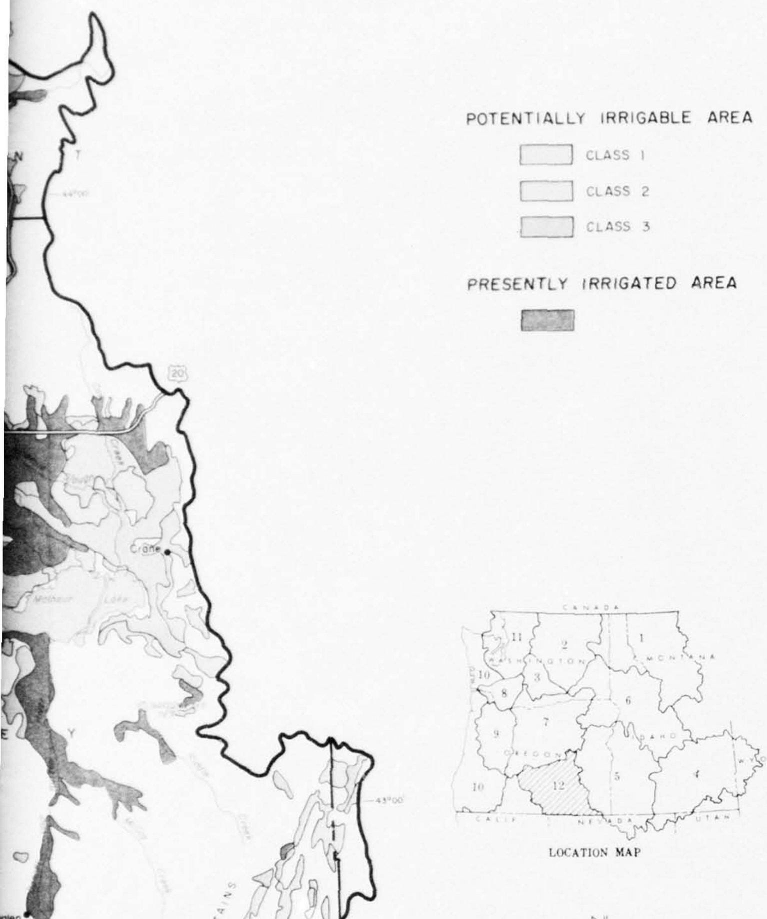
Lands under irrigation in 1966 were estimated to total about 327,000 acres, most of it irrigated from surface sources. This acreage consists almost entirely of irrigated pasture and hay. However, it does include some cultivated crops and a small acreage in urban or suburban development, forest nurseries, seed orchards, and recreation areas. The subregion acreages are presented in table 161 by subareas.

### Characteristics of Irrigated Area

The major irrigation development is found on the eastern side of the subregion in the Summer Lake-Malheur Lake Subarea along the courses of the Silvies and Donner and Blitzen Rivers, Silver Creek, and in the Catlow Valley south of Frenchglen. Concentrations also occur in the southwestern portion of this subarea near Paisley, Warner Valley, Silver Lake (western), and Summer Lake. The other subareas also have irrigated land. In the Alvord Lake Subarea,

GRANT
CROOK
DESCHUTES
KLAMATH
LAKE
HARNEY
OREGON
NEVADA
China Hat
Glass Butte
BURNS
Hines
Seneca
Crane
Fort Rock
Christmas Lake Valley
Wagontire
Silver Lake
Summer Lake
Wildcat Mtn
Juniper Mtn
Frenchglen
Paisley
Lake Abert
Beatys Butte
Fields
Alvord Desert
STEEN MOUNTAINS
Harney Lake
Malheur Lake
44°00'
43°00'
42°00'
120°00'
121°00'
SCALE IN MILES

2




COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

# IRRIGATED AND POTENTIALLY IRRIGABLE AREAS

OREGON CLOSED BASIN
SUBREGION 12
1968

FIGURE 57

Table 161 - Irrigated Area, 1966, Subregion 12

| Subarea | Source of Supply | | Adequacy of Supply | | Method of Application | | Total |
|---|---|---|---|---|---|---|---|
| | Surface | Ground | Adeq. | Inadeq. | Gravity | Sprinkler | |
| | | | | (acres) | | | |
| Summer L. Malheur L. | 263,900 | 7,700 | 40,000 | 231,600 | 259,900 | 11,700 | 271,600 |
| Upper Silvies R. | 23,800 | 100 | 2,200 | 21,700 | 23,700 | 200 | 23,900 |
| Alvord L. | 24,700 | 6,800 | 7,100 | 24,400 | 24,600 | 6,900 | 31,500 |
| Total | 312,400 | 14,600 | 49,300 | 277,700 | 308,200 | 18,800 | 327,000 |

Source: Data gathered from Soil Conservation Service, Bureau of Reclamation, and various state and local agencies.

irrigated lands occur along Trout and Whitehorse Creeks and just north of Alvord Lake and Alvord Desert. In the Upper Silvies River subarea irrigated lands are located along that stream. Figure 57 shows the distribution of these lands. A large part of the irrigated acreage is in the Malheur National Wildlife Refuge where native grass pasture and hay are produced on "flood meadows" which also provide nesting areas for waterfowl and other wildlife.

Most irrigation is done on an individual farm basis. However, several irrigation districts have been formed: The Chewaucan Irrigation District, organized in 1963, has 30,000 acres; Silver Lake Irrigation District, organized in 1921, has 2,600 acres; and Summer Lake Irrigation District, organized in 1920, has 2,500 acres.

Irrigated agriculture has great influence on the subregion's economy. Data derived from the 1964 Census of Agriculture, the source which forms the basis of this study of the agricultural economy, indicate that an estimated 45 percent of the livestock production is derived from irrigated crops grown within the subregion. Harney and Lake Counties make up the Economic Subregion.

The irrigated farms of Subregion 12 are large and rely on beef cattle or sheep to provide the major source of income. Hay and pasture, the principal irrigated crops, play an important role in supporting the livestock industry. Figure 58 shows the acreage of irrigated cropland harvested and the irrigated pasture for the subregion. The subregion includes nearly 12 million acres of land of which about 2.3 million acres were included in farms in 1964. This farmland was divided into 622 farms or ranches; 460 were irrigated to some extent. The average irrigated farm is over 4,600 acres in size and includes about 630 irrigated acres.

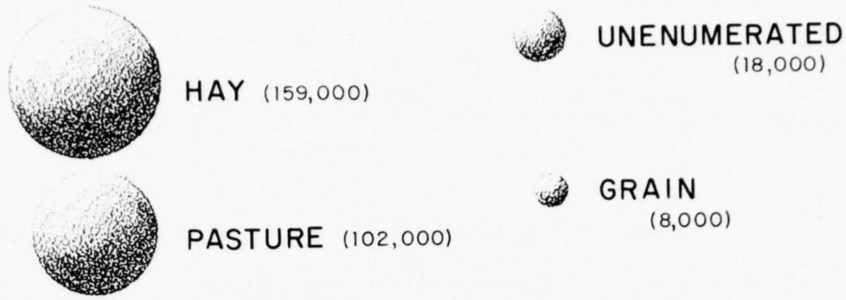



FIGURE 58. Acreage of Irrigated Cropland Harvested and Pasture, 1964, Subregion 12.

## Production of Irrigated Crops

Small grains and forage crops are virtually the only irrigated crops grown in this subregion. This is primarily due to climatic restrictions. A comparison of irrigated production with total production, presented in table 162, indicates three-fourths of the hay production and nearly one-third of the grain production comes from irrigated land.

Table 162 - Summary of Crop Production, 1964, Subregion 12

| Crop Category | Units | Production Total (1000's) | Production Irrigated (1000's) | Percent Irrigated |
|---|---|---|---|---|
| Small grains | tons | 20 | 6 | 30.0 |
| All hay | tons | 275 | 210 | 76.4 |

Source: Derived from Census of Agriculture and Agricultural Statistics.

Yields of selected irrigated grain and forage crops are presented in table 163. The climatic restrictions are reflected in these yields which are lower than for most other areas in the region.

## Value of Production

The gross value of crop and livestock production associated with irrigated land was estimated at nearly $5 million in 1964. A breakdown of this value is presented in table 164.

Table 163 - Yields of Selected Major Irrigated Crops, 1964, Subregion 12

| Crops | Units | Yield per Irrigated Acre |
|---|---|---|
| Small grain | | |
| Wheat | tons | 0.91 |
| Oats | tons | 0.73 |
| Hay and silage | | |
| Alfalfa | tons | 2.6 |
| Clover | tons | 1.4 |
| Grain hay | tons | 1.5 |
| Wild hay | tons | 1.1 |
| Silage | tons | 11.0 |

Table 164 - Estimated Value of Production from Irrigated Land Subregion 12

| | $ Million |
|---|---|
| Field crops (other than vegetables and fruit) | 0.2 |
| Vegetables | 1/ |
| Fruit | 1/ |
| Livestock and livestock products | 4.2 |
| Other | 0.3 |
| Total | 4.7 |

Source: Data derived from 1964 Census of Agriculture.
1/ Under $50,000.

The revenue from crop sales amounts to only about 4 percent of total sales of the output of irrigated land. This is the case because feed crops that are consumed in the area represent the major portion of crops produced on irrigated land. The portion of feed crops grown and consumed in the subregion was assumed to be about 80 percent. The remaining 20 percent was marketed outside the subregion and was included in the crop sale category. Most of the income from livestock results from the sale of beef calves and yearlings, lambs, and wool.

## Economic and Social Impacts from Irrigation

Additional employment and the change in gross economic product are used to reflect the impact of irrigation on the subregion.

Total employment was estimated to be 5,300 people in 1964. Approximately 1,400 of these people are employed by the local lumber industry and about 1,100 are employed in agriculture. This leaves 2,800 people to service both industries.

The direct value of irrigated agricultural production is $4.7 million. In the Columbia Basin Project area of Washington, the "indirect" or "additional" value resulting from goods and services supplied by allied industry to irrigated agriculture was found to be 2.54 times the direct value. For the Closed Basin Subregion, this estimate is probably too high. There is no agricultural processing done in the area, and much of the major purchasing and marketing is done in Bend, Ontario, and Klamath Falls, all of which are outside the subregion. For this reason, a much lower but as yet undetermined multiplier would be more appropriate for this subregion.

## Use of Water

Over 95 percent of the irrigated land receives its water supply from surface water sources--primarily from natural streamflow, supplemented by a small amount of stored water. Ground water supplies are used on only 5 percent of the irrigated land. There are only a few areas where adequate ground water supplies are available at depths from which they can be pumped economically for irrigation use. Estimated average irrigation water use is summarized for the 1966 level of development in tables 165 and 166.

Since few records of water use are available, diversion quantities are based on estimates of consumptive use and irrigation water requirements and then reduced by estimated average shortages. Some 749,000 acre-feet of water are diverted or pumped for irrigation use. This amount includes the water delivered to the farm and the distribution system losses and operational wastes. System losses are small where water is pumped from the source directly to the farm.

Farm losses, distribution system losses, and waste total about 407,000 acre-feet annually. It is estimated that 20 percent is lost to nonbeneficial consumptive use, so water actually returning to stream channels or recharging ground water supplies totals about 327,000 acre-feet. Subtracting this figure from the 749,000 acre-feet of diversions indicates that irrigators deplete about 422,000 acre-feet of water annually from subregion streams and ground water aquifers.

Table 165 - Irrigation From Surface Water Sources, 1966 Level, Subregion 12

| Subarea | Adequate Supply Area (acres) | Adequate Supply Diversion (ac-ft) | Inadequate Supply Area (acres) | Inadequate Supply Diversion (ac-ft) | Return Flow (ac-ft) | Depletion (ac-ft) |
|---|---|---|---|---|---|---|
| Summer L.-Malheur L. | 32,300 | 107,000 | 231,600 | 458,000 | 247,000 | 318,000 |
| Upper Silvies River | 2,100 | 7,000 | 21,700 | 57,000 | 28,000 | 36,000 |
| Alvord L. | 1,200 | 4,000 | 23,500 | 72,000 | 34,000 | 42,000 |
| Total | 35,600 | 118,000 | 276,800 | 587,000 | 309,000 | 396,000 |

Source: Bureau of Reclamation and Soil Conservation Service data.

Table 166 - Irrigation From Ground Water Sources, 1966 Level, Subregion 12

| Subarea | Adequate Supply Area (acres) | Adequate Supply Diversion (ac-ft) | Inadequate Supply Area (acres) | Inadequate Supply Diversion (ac-ft) | Return Flow (ac-ft) | Depletion (ac-ft) |
|---|---|---|---|---|---|---|
| Summer L.-Malheur L. | 7,700 | 23,000 | - | - | 9,000 | 14,000 |
| Upper Silvies River | 100 | 0 1/ | - | - | 0 1/ | 0 1/ |
| Alvord L. | 5,900 | 19,000 | 900 | 2,000 | 9,000 | 12,000 |
| Total | 13,700 | 42,000 | 900 | 2,000 | 18,000 | 26,000 |

Source: Bureau of Reclamation and Soil Conservation Service data.
1/ Less than 500 acre-feet.

## Adequacy of Supply

Surface-water supplies are generally inadequate throughout the subregion because of over-appropriation of low summer streamflows. Nearly 90 percent of the lands using surface water are inadequately supplied. Their annual shortage is about 330,000 acre-feet or 36 percent of the diversion requirement.

Ground water supplies are generally adequate. About 6 percent of the subregion's ground water irrigated land is inadequately supplied.

## Application of Water

The common method of irrigation is to divert water directly from streams and use borders, corrugations, or wild flooding to spread it on the land. However, sprinkler systems are used almost exclusively for the small acreage supplied by water pumped from the ground. Sprinklers are also on the increase on farms which use surface water supplies. Many large wheel-move systems are now in use, and their numbers are growing each year. There are a few self-propelled center pivot systems, and it is expected that these will replace many of the older hand-move and flood irrigation systems.

## Quality of Water

The quality of surface runoff is generally satisfactory for irrigation use. However, most of the lakes are too saline to serve as good water sources for irrigation. Ground and spring water is usually adequate in quality for irrigation use, although in local areas potentially toxic amounts of sodium and boron salts occur.

# FUTURE NEEDS

Expansion of irrigation in the subregion is necessary to help meet the future regional food and fiber requirements as well as to serve the need of other uses such as wildlife habitat improvement areas and recreation sites. These future irrigation needs can be met by furnishing supplemental water where supplies are presently inadequate and a full water supply to newly irrigated lands. Of the 327,000 acres irrigated in 1966, some 277,700 acres are in need of supplemental supplies. A limited water supply will have a marked influence on irrigation development in the future.

## Lands

Satisfaction of future irrigated area needs can be met with little development of new irrigation. For the most part, increased yields and supplemental water for the existing irrigated area will be sufficient. Even so a slight increase in irrigated acreage needs is projected. Future acreages are identified in table 167.

Table 167 - Irrigated Area Needs by 1980, 2000, and 2020, Subregion 12

| Item | Irrigated Acreage | | |
|---|---|---|---|
| | 1980 | 2000 | 2020 |
| | | (1000's) | |
| Harvested cropland and pasture 1/ | 280 | 289 | 289 |
| Other 2/ | 50 | 51 | 51 |
| Total irrigated area | 330 | 340 | 340 |

1/ From table 168.
2/ Includes irrigated forest, range, rights-of-way, ditches, roadways, farmsteads, urban, and idle irrigated lands not used in the production of projected crop requirements.

The total irrigated area figures were determined first by identifying needed productive irrigated cropland and pasture and then adjusting the results to include irrigated lands used for purposes other than crop and pasture production. Irrigated cropland harvested and pasture acreages are presented by crop category in table 168.

Table 168 - Irrigated Cropland Harvested and Pasture Needed to Meet Projected Production Requirements by 1980, 2000, and 2020, Subregion 12

| Crop Category | Acreage Needs | | |
|---|---|---|---|
| | 1980 | 2000 | 2020 |
| | | (1000's) | |
| Small grains | 7 | 6 | 7 |
| All hay | 156 | 161 | 161 |
| Pasture | 99 | 103 | 102 |
| Unenumerated | 18 | 19 | 19 |
| Total | 280 | 289 | 289 |

## Production and Yield

A summary of crop production from irrigated land is presented in table 169. Projected crop yields for small grain and hay categories are presented in index form on figure 59. The indexes represent percentage increases in yield over the 1964 level on a weighted average basis. Yields for 1964 were set at a base of 100.

Table 169 - Crop Production from Projected Irrigated Acreage for 1980, 2000, and 2020, Subregion 12

| Crop Category | Units | Production 1980 | 2000 (1000's) | 2020 |
|---|---|---|---|---|
| Small grain | tons | 8 | 9 | 13 |
| Hay | tons | 284 | 341 | 429 |

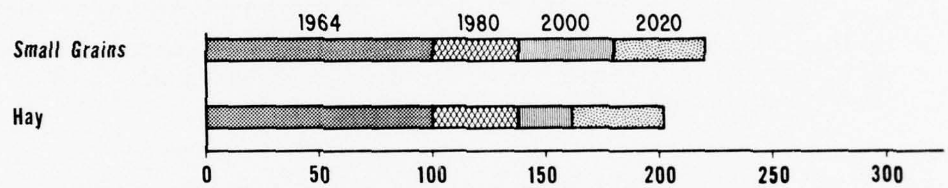



FIGURE 59. Yields for Selected Crops for 1980, 2000, and 2020 (1964 as Base Year Equals 100), Subregion 12.

## Value of Production

Projected values of irrigated crop production are presented in table 170. These values include irrigated crops consumed by livestock with the exception of pasture for which no estimates were made. The values are based on projected production from irrigated land and the same price structure established by OBERS in the regional projections.

## Water

Additional depletions resulting from meeting supplemental irrigation needs and from irrigation needs of expected new development will total approximately 208,000 acre-feet by 2020. This figure combined with 1966 depletions of 422,000 acre-feet indicates that by 2020 some 630,000 acre-feet will be depleted from Subregion 12.

Table 170 - Value of Projected Irrigated Crop Production, Subregion 12

| Crop Category | Value of Production 1/ 1980 | 2000 ($1,000) | 2020 |
|---|---|---|---|
| Small grains | 400 | 500 | 700 |
| Hay | 6,100 | 7,300 | 9,200 |
| Dry beans and peas | - | - | - |
| Sugar beets | - | - | - |
| Potatoes | - | - | - |
| Vegetables | - | - | - |
| Fruits, nuts, and berries | - | - | - |
| Forage seed, hops, and mint | - | - | - |
| Total | 6,500 | 7,800 | 9,900 |

1/ Based on projected normalized prices.

water supplies as a result of irrigation. Depletions and farm deliveries are summarized by time periods in table 171. Note that projected depletions level off after 2000.

Table 171 - Irrigation Water Needs Subregion 12

| | Presently Irrigated | | Future Irrigation | | Total | |
|---|---|---|---|---|---|---|
| Year | Farm Delivery | Depletion | Farm Delivery | Depletion | Farm Delivery | Depletion |
| | | | (1,000 ac-ft) | | | |
| 1966 | 636 | 422 | | | 636 | 422 |
| 1980 | 730 | 480 | 10 | 10 | 740 | 490 |
| 2000 | 930 | 610 | 40 | 20 | 970 | 630 |
| 2020 | 930 | 610 | 40 | 20 | 970 | 630 |

Supplemental

Additional diversions of 330,000 acre-feet are needed by 278,000 acres of inadequately supplied lands. This will provide additional farm deliveries of 294,000 acre-feet and result in additional depletions of 188,000 acre-feet. Estimated supplemental water requirements are shown by subarea in table 172.

Table 172 - Supplemental Irrigation Water Requirements
Subregion 12

| Subarea | Water-Short Lands (acres) | Supplemental Diversion Requirement (acre-feet) |
|---|---|---|
| Summer Lake-Malheur Lake | 231,600 | 306,000 |
| Upper Silvies River | 21,700 | 10,000 |
| Alvord Lake | 24,400 | 14,000 |
| Total | 277,700 | 330,000 |

Full

Irrigable lands in the subregion are generally between 4000 and 5000 feet above sea level. Thus, irrigation water requirements are quite low in comparison to lower lands east of the Cascade Range. The subregion was divided into three subareas for estimating farm delivery requirements and depletions shown in table 173.

Table 173 - Irrigation Requirements and Depletions
Subregion 12

| Subarea | Present-2000 | | 2000-2020 | |
|---|---|---|---|---|
| | Farm Delivery | Depletion | Farm Delivery | Depletion |
| | (AF/ac.) | | | |
| Upper Silvies | 2.8 | 1.7 | 3.0 | 2.1 |
| Summer-Malheur Lakes | 3.0 | 1.9 | 3.2 | 2.2 |
| Alvord | 3.2 | 2.0 | 3.3 | 2.3 |

The Upper Silvies area is farther north than the other lands and has slightly less water requirement. The Alvord-Tum Tum area is farthest east and is separated from most of the subregion by the Steens and Pueblo Mountains and has a slightly higher requirement.

THE POTENTIAL TO MEET THE NEEDS

The Oregon Closed Basin Subregion has extensive areas of potentially irrigable land, but a very limited water supply. This along with short growing seasons will continue to hinder irrigation

expansion. This subregion does not have enough surface water originating within the subregion to supply all of the potentially irrigable lands. If ground water supplies can be found and utilized they will need to be fully integrated with surface flows to not only reduce irrigated shortages on the 327,000 acres presently irrigated but permit the irrigation development of an additional 13,000 acres of new lands needed by 2020.

*This scene on U. S. Highway 395 near Wagontire in the northwestern part of the subregion is typical of the Oregon Closed Basin. (Oregon State Highway Commission)*

## Potentially Irrigable Land

The potentially irrigable land in Subregion 12 totals nearly 3 million acres, or about 9 percent of the potentially irrigable land in the Columbia-North Pacific Region. This includes land in both public and private ownership and in both agricultural and non-agricultural use. Table 174 lists this acreage by land classes; their general location is shown on figure 57.

The soils of the subregion have developed under arid climatic conditions from parent materials consisting of lake sediments,

Table 174 - Potentially Irrigable Land, 1966, Subregion 12

| Subarea | Class 1 | Class 2 | Class 3 | Total |
|---|---|---|---|---|
| | | (acres) | | |
| Summer-Malheur Lakes | 110,100 | 423,300 | 1,831,300 | 2,364,700 |
| Upper Silvies River | - | 38,000 | 17,200 | 55,200 |
| Alvord Lake | 54,900 | 109,600 | 350,000 | 514,500 |
| Total | 165,000 | 570,900 | 2,198,500 | 2,934,400 |

Source: Acreages prepared by the Bureau of Reclamation based largely on data provided by the State of Oregon and supplemented by information from the Department of Interior and Department of Agriculture.

Aeolian deposits, alluvial materials, and combinations of lake-wind-stream deposited materials. Soil textures range from sands to clays. With irrigation project development, some drainage facilities would be required because of inadequate natural drain outlets and the presence of barrier layers in the substrata. A brief description of the three potentially irrigable classes follows.

Class 1

Class 1 lands total about 165,000 acres, 6 percent of the potentially irrigable acreage. They are well suited for irrigation and are capable of high production of all the climatically adapted crops. They have good deep soils which are easy to cultivate, and they occur in large smooth bodies which can be irrigated efficiently.

Class 2

Class 2 lands consist of about 570,900 acres, or 19 percent of the potentially irrigable total. These lands are of good quality but have some minor deficiency which will reduce their productivity under irrigation below the class 1 level. In most cases, the deficiencies which will reduce crop yields slightly below the class 1 average are in soil quality or in shallowness of soil overlying gravel or rock.

Class 3

About 2,198,500 acres, 75 percent of the potentially irrigable land in Subregion 12, is included in this class. It has a narrower crop range than class 1 and 2 land, and is best suited for irrigated pasture and hay. However, the entire subregion is primarily a livestock area, and as pasture and hay are the principal irrigated crops grown, class 3 lands compare more favorably here with higher

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class land than they do in some other areas. The most common deficiencies are fine textured soils, limited soil depth over rock or hardpan, steep or rolling topography, or a combination of these factors. Under irrigation some class 3 lands would require careful management to guard against saline or alkali salt accumulating in the crop rooting zone. The class 3 acreage includes about 175,000 acres of marginal quality in the Summer Lake-Malheur Lake subarea which has been identified as having irrigation potential for wildlife forage production, wildlife habitat improvement, recreation, or for scenic area development.

## Water Supply

The average annual runoff generated within the subregion is about 1.2 million acre-feet. Unlike other subregions, there is no drainage to the sea. Streams drain into brackish landlocked lakes and runoff is dissipated by evaporation.

The amount of ground water stored at depths of 50 to 100 feet below the water table is about 56 million acre-feet. Annual natural discharge contributes significantly to surface streamflows and amounts to about 800,000 acre-feet annually. Mining of ground water in this subregion would lower the water table, thus reducing evaporation and transpiration losses. This action could make more water available for irrigation, but possibly at the expense of other uses.

## Potential Developments

Subregion 12 has a limited water supply and can only meet a token amount of the region's future food and fiber requirement. Large, accessible ground water sources are not available for irrigation expansion and if storage with considerable carry over capacity is not provided the only sources of water for major irrigation development would lie outside the subregion.

### Development by Subarea

The Summer Lake-Malheur Lake subarea has the greatest potential for additional irrigation development. However, because of the water supply situation and the low requirement for additional irrigation in Subregion 12, no large-scale developments are anticipated.

### Private

Based on current information relative to the availability of water supplies, it is anticipated that future irrigation development

will continue on an individual basis rather than by a major cooperative effort.

## Federal

Several studies have been made of the Silvies basin by Federal agencies to develop a project-type irrigation development. In 1916, a Federal agency in cooperation with the Oregon State Engineer published a report of the Silvies basin. Since the original report, several brief studies have been conducted by Federal agencies. Water right problems have been the major block in providing storage for the area. It appears that any project developing from this study would require storage with holdover reservoir capacity.

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# G L O S S A R Y

Note: Definitions of technical terms used in this appendix are presented in this glossary. In general, terms having a common dictionary definition or those for which a definition is provided as a part of the narrative have not been included.

ACRE-FOOT (ac.ft.) - a measuring unit for volume of water or sediment.

AQUIFER - a rock formation, bed or zone containing water that is available to wells. An aquifer may be referred to as a water-bearing formation or water-bearing bed.

CONSUMPTIVE USE - the quantity of water that is absorbed by the crop and transpired or used directly in the building of plant tissue, together with that evaporated from the cropped area.

CUBIC FEET PER SECOND (c.f.s.) - a unit expressing rate of discharge. One cubic foot per second is equal to the discharge of a stream having a cross-section of one square foot and flowing at an average velocity of one foot per second. It equals a rate of 448.8 gallons per minute.

CURRENT NORMAL AGRICULTURAL PRODUCTION - a concept used to describe estimates which conform with or constitute an acceptable model or pattern. Acreage, production, price and value of crop production; and production, price and value of livestock production have been adjusted to conform to a consistent pattern. Current normal values of any of the above parameters are estimates which reflect current production technology and practices, from which abnormalities caused by weather, etc., have been removed.

CURRENT NORMALIZED CROP YIELD - Yield estimates which reflect current production technology and practices from which abnormalities caused by weather, etc., have been eliminated.

DEPLETION - that portion of water supply that is consumptively used, beneficially or nonbeneficially.

EFFECTIVE PRECIPITATION - that part of the precipitation falling on a crop area that is effective in meeting the consumptive use requirements of the crop.

EVAPOTRANSPIRATION - water dissipated from a land area by evaporation from water surfaces and moist soil, and by plant transpiration.

FARM DELIVERY REQUIREMENT - the amount of water in acre-feet per acre required to serve a cropped area from a canal or pipe turnout. It is the crop irrigation requirement plus farm waste and deep percolation.

GROUND WATER - water in the ground that is in the zone of saturation from which wells, springs, and ground water runoff are supplied.

GROWING SEASON - the number of consecutive days having minimum temperatures above 32° F.

HYDROLOGIC CYCLE - the circulation of water from the sea, through the atmosphere, to the land; and, thence, with many delays, back to the sea by overland and subterranean routes, and in part by way of the atmosphere without reaching the sea.

IRRIGATED AREA - a composite of cropland harvested and pasture, nonharvested cropland and other nonproductive and nonagricultural lands receiving an irrigation water supply.

IRRIGATED LAND, FULL SERVICE - irrigated land with a full and adequate water supply.

IRRIGATED LAND, PARTIAL SERVICE - irrigated land with a partial and inadequate water supply.

IRRIGATION REQUIREMENT, CROP - the amount of irrigation water in acre-feet per acre required by the crop; it is the difference between crop consumptive use requirement and effective precipitation.

POTENTIALLY IRRIGABLE LAND - land having soil, topography, drainage, and climatic conditions suitable for irrigation. (C.N.P.)

PRESENTLY IRRIGATED LAND - land receiving water by controlled artificial means for agricultural purposes from surface or subsurface sources. (C.N.P.)

RAINSHADOW - the area of diminished rainfall on the lee side of a mountain or mountain range, where the rainfall is noticeably less than on the windward side.

RETURN FLOW - irrigation water applied to an area which is not consumed in evaporation or transpiration and returns to a surface stream or ground water aquifer.

RIPARIAN - pertaining to the banks of streams, lakes, or tidewater.

RUNOFF - that part of the precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage or other works of man in or on the stream channels.

SLICK SPOT - small areas in a field that are slick when wet because they contain excess exchangeable sodium or alkali.

STREAMFLOW DEPLETION - the amount of water flowing into a valley or onto a particular land area, minus the amount of water that flows out of the valley or off from the particular land area.

SUBIRRIGATED LAND - land with a high water table condition, either naturally or artificially controlled, that normally supplies a crop irrigation requirement.

SUBSOIL - that portion of the soil profile below plow depth. It generally is 10 to 32 inches below the surface.

SUPPLEMENTAL IRRIGATION - when irrigation water supplies are obtained from more than one source, the source furnishing the initial supply is commonly designated the primary source; and the sources furnishing the additional supplies, the supplemental sources.

## PARTICIPATING STATES AND AGENCIES

### STATES

*Idaho* *Nevada* *Utah* *Wyoming*
Montana Oregon Washington

### FEDERAL AGENCIES

Department of Agriculture
- Economic Research Service
- Forest Service
- Soil Conservation Service

Department of the Army
- Corps of Engineer

Department of Commerce
- Economic Development Adm.
- National Oceanic & Atmospheric Administration
  - National Weather Service
  - National Marine Fisheries Service

Department of Health, Education, & Welfare
- Public Health Service

Department of Housing & Urban Development

Department of Transportation

Department of the Interior
- Bonneville Power Adm.
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Mines
- Bureau of Outdoor Recreation
- Bureau of Reclamation
- Federal Water Quality Adm.
- Fish and Wildlife Service
- Geological Survey
- National Park Service

Department of Labor

Federal Power Commission

INTERIOR--PORTLAND, OREGON